Package Practices For Kharif Crops

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PACKAGE OF PRACTICES FOR KHARIF CROPS

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GRAIN CROPS

RICE

The importance of rice has considerably increased in recent years because of the changing agro-climatic conditions, viz. increased rainfall, water-logging and increased availability of irrigation water. Because of the high yielding dwarf varieties (80% area) and improved crop technology, this crop has gained importance as compared to other **kharif** crops in Haryana. Accordingly, the area under rice cultivation has increased considerably. Now, this State has started contributing substantial of rice to the Central Pool. During the last 10 years the area under cultivation and production has been as given as under :

	86	87	88	89	90	91	92	93	94	95
Area ('000 ha)	628	464	583	605	672	618	698	755	796	837
Production ('000 ton)	1543	1084	1396	1654	1823	1748	1850	2061	2230	1860
Average yield (kg/ha)	2457	2336	2395	2734	2773	2828	2650	2730	2801	2222

With the spread of high yielding varieties and the adoption of better crop management practices, the rich production can be substantially increased in the State.

IMPROVED VARIETIES

Medium Duration

Jaya : A short statured (115 cm), high yielding Indica variety, similar to IR-8 in all morphological and physiological characters, few days earlier than IR-8 and gives 3-5 per- cent more yield than IR-8. Average yield 26 q per acre.

Caution

(i) Jaya variety is not suitable for water-logged areas.

(ii) This variety does not give high yields if transplanted after first week of July.

PR-106 : A short statured, lodging resistant and high yielding Indica variety. Its grains are long slender. It takes 140-145 days from seed to seed. Average yield is 24 q per acre.

HKR-120 : A short statured (105 cm), high yielding medium duration (146 days seed to seed) Indica variety. It is stiff-strawed, non-lodging and highly responsive to high levels of fertilization. Its grains are long slender. It is resistant to bacterial leaf blight (BLB) and white backed plant hopper (WBPH) and moderately resistant to stem rot disease. Its average yield is 25 q per acre.

HKR-126 : A short statured (110 cm), high yielding, medium duration (140 days seed to seed) Indica variety. It is stiff-strawed and highly responsive to high levels of fertilizer application. It's grains are long slender. It is resistant to white backed plant hopper (WBPH) and stem-rot and moderately resistant to bacterial leaf blight (BLB). It tolerates water stress. Its average yield is 27 q/acre.

Short Duration

IR-64 : A short statured (108 cm), high yielding Indica variety of superfine quality (long slender) of rice. It is stiff-strawed, non-lodging and highly responsive to fertility levels. Takes 135 days from seed to seed. Moderately resistant to stem-rot and WBPH. Its average yield is 23 q per acre.

Pusa-33 : A short statured, lodging resistant and early maturing Indica variety. Its grains are long slender. It takes 115-120 days duration from seed to seed and this is suitable for late sown conditions and multiple cropping. Its average yield is 21 q per acre.

Govind : A semi-dwarf (93 cm), non-lodging and very early maturing Indica variety. Its kernels are long slender. It taken 115 days from seed to seed. It is suitable for multiple cropping and early to late planting. Moderately resistant to stem-rot. The average yield is 21 q/acre.

Climatic Requirements

High temperature, high humidity, assured water supply and prolonged sunshine are suitable for rice cultivation. 20° to 37.5° temperature is congenial for its growth. High temperature is required at tillering stage. At earing stage, the temperature should be between 26.5° to 29.5°. In Haryana, rice is grown from May to November.

AGRONOMIC PRACTICES

Soil and its Preparation

Rice grows best on loam to clay loam soils that turn into soft mud when puddled and developed cracks on drying. It can also be cultivated on alkaline soils and from open to poorly drained soils.

The first ploughing may be given with soil turning plough and subsequent ploughings should be done with **desi** plough. Before transplanting, the field is flooded with water and one to two ploughings followed by plankings are given in the standing water to puddle the soil thoroughly. It will help in maintaining good seedling vigour, control of weeds, and in minimising water losses due to deep percolation. Use puddler for proper puddling of the field.

Seed Treatment

Select heavy, disease free seed by dipping in 10% salt solution. To treat seed, needed for sowing for one acre put 1 kg salt in 10 litres of water. Dip 2-3 kg of seed in this solution and remove the empty and unhealthy seeds which float at the top. Collect heavy seed settling at the bottom and wash 2-3 times with water. 8-12 kg of seed selected by this method would be sufficient to raise nursery for one acre. Washing is done to remove the adhered salt which will otherwise reduce the seed germination. Heavy seed selected by this method ensures healthy, sturdy and uniform seedlings which result into uniform crop growth in the field.

Treat 10 kg seed with 5 gm Emisan and Streptocycline-1 g or Agrimycin-100 or Plantomycin 2.5 gm in 10 litres of water for 24 hours before sowing for seed borne diseases.

NURSERY RAISING

Time of Nursery Sowing

(i) Short duration dwarf varieties : May 15 to June 30

(ii) Medium duration dwarf varieties : May 15 to May 30

Method of Sowing

Mix well-rotten Farm Yard Manure or compost @ 10-12 cart load per acre with the soil by repeated ploughings. Flood the field

and puddle it well. Apply 10 kg N and 10 kg P_2O_5 and 10 kg $ZnSO_4$ per acre of nursery area and give planking to level the field. Divide the field into plots of convenient size.

When the silt has settled (about 4-5 hours after final planking) sow the treated and pregerminated seed @ 40-50 gm/m² i.e. 1.6-2 q/acre. Apply shallow irrigations preferably in the evening so that water does not remain standing in the nursery during sunny hours. Apply another dose of N @ 10 kg/acre about a fortnight after sowing.

There is likelihood of the appearance of iron deficiency in case well rotten organic manure has not been applied. In such a situation 0.5% Ferrous sulphate solution should be sprayed immediately after the appearance of iron deficiency.

Direct Seeding of Rice

In Rohtak district or the areas where sufficient and regular supply of water is not available for nursery raising and puddling of field for transplanting, the rice crop may be grown by direct seeding of very early maturing varieties.

Sowing Time and Method

The direct seeding of rice may be done from 15th to 30th June coinciding with the onset of monsoon. Pre-sowing irrigation may be given and the field is prepared nicely at vattar condition. The seed rate may be used @ 25-30 kg/acre and the sowing may be done in lines at 20-25 cm spacing. Seed must be purchased from reliable sources and it should be treated before sowing for control of diseases as given earlier.

Irrigation

The crop must be irrigated as per its requirement and availability of irrigation water. It is most essential to irrigate the crop before the application of second and third dose of nitrogen. Moreover, sufficient soil water should be available to the crop at panicle initiation and grain development stages for higher productivity.

Weed Control

In direct seeded crop, weeds may be controlled by intercultural operations. Two to three hoeings are essential after 3-4 weeks of

sowing for effective weed control. If herbicides are to be used then apply butachlor or thiobencarb @ 1.2 lit/acre mixing in 200-250 lit. of water as pre-emergence weedicide (before germination and after sowing of seed). The weeding by wheel hand hoe or Kasola before application or second dose of nitrogen to crop is beneficial. Later on, weeding may be done by hand in standing water during monsoon/rainy season.

Chemical Control of Rice-root Nematode

On the basis of random surveys conducted in the State, it has been observed that rice-root nematode (*H. oryzae)* is commonly present in the paddy growing areas of the State and its population is increasing. This nematode is serious in certain pockets of Kurukshetra and Sirsa districts having heavy and saturated or water logged soils. This migratory endoparasitic nematode attacks the rice root throughout the growing period. Nematode burrows inside roots and causes extension damage in roots. Affected roots turn brown to reddish brown in colour with reduced growth. Severe damage results in rotting of roots. As a result the plant becomes yellowish with depressed and delayed tillering and flowering and suppressed root and shoot growth resulting into poor yield. To control this nematode, nursery bed treatment with carbofuran @ 400 g a. i./acre (Furadon 3-G @ 3.4 g/m^2) at the time of sowing proves most effective in blocking the entry of nematodes in roots and thereby increasing the growth of paddy seedlings and gain in crop yield. This treatment is particularly recommended for Kurukshetra district and Rania block of Sirsa district.

Chemical Control of Weeds in Rice Nursery

The weeds can be controlled in rice nursery by use of butachlor (Machete EC, Delchlor EC, Hiltachlor EC) @ 1.2 litre per acre or thiobencarb (Saturn EC) @ 1.2 litre per acre or pendimethalin (Stomp) @ 1.2 litre per acre mixed with 60 kg of dry sand. six days after sowing of pre-germinated rice seed in one acre of nursery area. The weed control efficiency can be achieved around 50 to 60 per cent.

Age of Seedlings

For short duration dwarf varieties optimum age of seedlings is 25 to 30 days.

In case of medium duration varieties for June transplanting use 30 days' seedlings. With regard to transplanting in July use seedlings from the nursery sown in May ranging upto 60 days' age.

Uprooting of Seedlings

The seedbed should be watered a day prior to the uprooting of the seedlings. The seedlings should be pulled out gently. To remove mud, wash the seedlings gently in water. Uprooting the single plants, holding them as low as possible would minimise the damage.

TRANSPLANTATION

Time of Transplanting

Short duration dwarf varieties : 15th June to end of July

Medium duration dwarf varieties : 15th June to 7th July

Method of Transplanting

Transplant 2-3 seedlings per hill in well-puddled fields with spacing of 22.5 × 15 cm for normal and 15 cm × 15 cm for late transplanting in case of tall varieties: and 15 cm × 15 cm for both normal and late transplanting in case of short-statured, high-yielding varieties. The seedlings should be transplanted upright. Seedlings should not be more than 2-3 cm deep when the puddle settles. This enables good establishmeat of seedlings and early tillering, which is necessary for good tiller development and synchronous flowering.

Fertilizers

Fertilizer recommendation for dwarf rice varieties

Variety	Nutrients (kg/acre)			Fertilizer (kg/acre)			
	N	P_2O_5	K_2O	Urea	SSP	Muriate of potash	Zinc sulphate
Medium duration varieties (PR-106, HKR-120, HKR-126)	60	24	24	130	150	40	10
Short duration varieties (Palman-579, IR-64, Poosa-33, Govind)	48	24	24	105	150	40	10

For dwarf varieties, drill all P, K, Zn and 1/3 N at puddling. Apply rest N in two splits—first, 3 weeks after transplanting and second, three weeks afterwards.

For dwarf as well as tall varieties of rice, phosphorus may also be profitably applied in two splits, viz., half at puddling and the remaining by top dressing three weeks after transplanting. The basal dose of 1/3rd N can also be applied within seven days of transplanting by top dressing of Urea or Ammonium Sulphate.

If zinc sulphate has not been applied to previous crop apply 10 kg zinc sulphate per acre at the time of puddling or latest upto 10 days after transplanting. Spray zinc sulphate if it has not been applied at the time of transplanting. Three sprays (0.5% Zinc sulphate+0.25% slaked lime or 2.5% urea) should be done. First spray should be done one month after transplanting and the remaining two at 15 days intervals.

Nitrogen should preferably be given in ammonical form. Urea and ammonium sulphate are more suitable for rice crop. If whole quantity is not available, CAN may be used as second and third dose only. For dwarf rice, if possible, field should be green manured.

For green manuring, use 8-10 kg/acre seed of Dhaincha and seed must be sown by fist week of May. Dhaincha crop of 45-50 days (with slender stems) be buried by 3rd week of June. In green manured fields apply 2/3rd of the recommended dose of NPK but full dose of zinc sulphate. Transplanting should be done within one week of green manuring.

Interculture

In the early and timely transplanted crop, give interculture by running paddy weeder 15 days after transplanting followed by another one after a fortnight. In the late tranplanted crop and in high-yielding varieties where paddy weeder cannot be run, hand weeding may be done. Weeding is vary important, though puddling helps to control the weeds.

Direct seeding of early varieties of paddy is useful practice in areas where irrigation facilities are limiting and puddling is not possible, like new areas such as Rohtak and Jind districts. In direct seeded paddy weeds should be controlled with the help of intercultural operations. Local plough can be used in between the rows for control of weeds. Two to three hoeings, starting after three to four weeks of sowing, are necessary.

Water Management

(i) Rice crop is greatly influenced by water-supply. Water should preferably be kept standing throughout the growth period with weekly replacement of fresh supplies. About 15-20 irrigations are necessary to mature the crop after transplanting. Never apply more than 5-6 cm depth of irrigation water. In case of limited supply of irrigation water, the field may be kept wet by repeated irrigation just before the soil reaches the saturation stage.

(ii) With hold water for a few days when seedlings are established (6-10 days after transplanting) for development of better root system of the plants; again at the peak vegetative growth to check growth of unproductive tillers and diverting the energies of the plant towards reproductive purpose.

(iii) Drain off excess water prior to applications of fertilizers and interculture of weeding and irrigate again after these operations.

(iv) About a week before maturity, the water may be cempletely drained off to facilitate easy harvesting and timely sowing of successive wheat crop.

Chemical Control of Weeds

Grassy weeds mostly infest paddy fields. Among these, *Sawank* and *mastha (Echinochloa* spp.*)* creates major problem. Such weeds can be effectively controlled by the use of anyone of the given herbicides :

Sr. No.	Name of herbicide	Dosage kg/lt. per acre	Method of application
1	2	3	4
1.	Butachlor (Machete EC, Delchlor EC and Hiltachlor EC, Milchlor Narbadachlor, Capchlor, Trap, Teer)	1.2	Mix with 60 kg per acre of dry sand and broadcast it uniformally in 4-5 cm of standing water within 2-3 days of transplanting.
2.	Butachlore G (Machete G, Narbadachlor G)	12	Broadcast uniformally in 4-5 cm standing water within 2-3 days of transplanting.

1	2	3	4
3.	Thiobencarb (Saturn EC)	1.2	Mix with 60 kg of dry sand and broadcast uniformally in 4 to 5 cm of standing water within 2 to 3 days of transplanting.
4.	Thiobencarb (Saturn G)	6	Broadcast uniformally in standing water (4 to 5 cm deep) within 2 to 3 days of transplanting.
5.	Pendimethalin (Stomp EC)	1.2	Mix with 60 kg of dry sand and broadcast uniformally in 4 to 5 cm of standing water within 2 to 3 days after transplanting.
6.	(i) Anilophos 30 EC (Arozin/Aniloguard Control-H)	0.53	-do-
	(ii) Anilophos 50 EC	0.325	-do-
	(iii) Anilophos 18 EC (Riko)	0.9	-do-
7.	Fluchloralin (Basalin EC)	500-600 ml	(i) Mix in 100 litres of water per acre and spray uniformally immediately after transplanting in standing water.
			(ii) Mix with 60 kg of dry sand and broadcast uniformally immediately after transplanting in standing water.
8.	Fluchloralin (Basalin G)	10-12	Broadcast uniformally in standing water immediately after transplanting.

Note : Avoid use of basalin where fields are likely to be infested with *(Cyprusiria)*. Also ensure to maintain standing water for two to three days after its application.

Harvesting and Threshing

The right stage of harvesting rice is just when the ears are nearly ripe and the straw has just turned yellow. There is loss of grain due to shattering if the harvesting is delayed. The milling quality of grain is also affected. Rice should be harvested with improved sickle (Navin)

manually. But combines could be successfully used for harvesting wherever it is available. The harvested crops should be threshed the same day and not left in the field exposed to dew. If it has to be left there overnight, cover the heap properly. Threshing can be done either by heating the sheaves against some hard surface just after harvesting or allowing the bullocks to tread on well dried plants. Paddy threshers are available for use.

Seed Production

For seed production, the nursery of the crop should not be grown in the field, where rice crop was grown during previous year The good healthy crop of rice may be selected for seed production purpose. The plants of other varieties and diseased plants may be roughed out thoroughly at least twice i. e. at heading and near maturity. The harvesting and threshing of this selected crop/variety may be done with care to avoid admixture. After drying and processing the seed, it must be stored in disinfested bins/store.

Storage and Marketing

It is in the interest of the farmers to bring their paddy produce from field to grain market directly for sale. By this way, he can save the expenditure on drying and storage of produce. For safe storage, the produce must be dired in sunshine for about a week or upto an optimum moisture content of 14% storage must be done in the treated bins or stores.

Rice Cultivation in Alkali Soils

Sizeable area on such soil exists in the State and the same has recently been reclaimed for cultivation. According to soil-test report, one or two heavy irrigations may be given and the water movement may not be allowed from one field to another. The recommended quantity of gypsum may be applied during summer before irrigation.

Field Preparation

Puddling is not required to be done, because water intake capacity of such soils is very low. Irrigate the harrowed/ploughed fields and use planking to break the clods and levelling of the field.

Transplanting

Initial growth of the rice plants is low in such soils. Therefore, transplanting may be done a week earlier than normal time of trans-

planting with 35-40 days old seedlings and 3-4 seedlings/hill. The spacing between rows and plants may be kept 20×15 cm or uniform randomly 35 hills/m^2 are required for proper plant stand. As the seedlings mortality and low-tillering are common under these soils, the number of seedlings/hill should be increased. The gap filling must be done after one week of planting.

Fertilizer

Alkali soils are low in organic carbon and the efficiency of nitrogenous fertilizer is also poor. Apply 60 kg nitrogen through 130 kg urea per acre in 3 equal splits i. e. at puddling, 3 weeks and 6 weeks after transplanting.

Phosphorus and potash are to be applied as per soil-test report. Apply 20 kg $ZnSO_4$ per acre at the time of field preparation for planting. Dhaincha is to be grown during summer for green manuring. Apply required quantity of phosphorus to dhaincha and omit the application of P to rice crop after its green manuring for better results.

Irrigation

Due to low water intake, light and frequent irrigations with good quality of water to the crop are essential for getting higher yields.

PLANT PROTECTION MEASURES

Insect Pests

Rice Root Weevil : The grubs feed on the roots on the soil from July to mid September. As a result the plants become yellow, lack tillering and remain stunted. This pest is serious in poorly managed fields.

In the field having moderate to serious infestation, apply 6 kg BHC 6 G or 10 kg carbaryl 4 G or 10 kg Sevidol 4 G per acre for the control of root weevil in the infested fields. If these granules are not available in that case 10 kg carbofuran (Furaden 3 G) or 4 kg phorate (Thimet 10 G) may also be applied against this pest. It is advisable to mix double the quantity of urea with the insecticide granules for uniform application.

Leaf Folder : Small, greenish and very active caterpillars scrap the green material of the folded leaves from inside from July to October. Spray 400 ml quinalphos (Ekalux) 20 A. F. or 500 ml monocrotophos

36 S. L. or 350 ml endosulphan 35 EC or 1 litre chlorpyriphos 20 EC or 500 ml methylparathion 50 EC or 250 ml phosphamidon 85 SL in 200 litres water/acre or apply methylparathion 2% dust @ 10 kg/acre.

Leaf and Plant Hoppers : The white backed plant hopper (WBPH) dominates over brown plant hopper (BPH) in Haryana. The initial damage to the crop is caused by the former species whereas the latter appears during maturity of the crop and does not cause much damage. The nymphs and adults suck the sap of the basal portion of the plant resulting in browning, yellowing and drying of the plants called "hopper burn". In the beginning the hopper burn is developed in patches which is spread in the whole field later on.

Dust the infested crop with methylparathion 2% dust or carbaryl (Sevin) 5% dust @ 10 kg/acre dust with 250 ml dichlorvos 76 EC after mixing in 1.5 l water and 20 kg fine dust or spray with 400 g carbaryl (Sevin) 50 W. P. or 350 ml endosulfan 35 EC or 250 ml monocrotophos 36 S. L./fenitrothion 50 EC/oxydemeton-methyl 25 EC or 65 ml phosphamidon 85 S. L. in 200 litres water per acre. Spray must be directed towards the base of the plant. Repeat the spray or dust after 10 days if required.

Gundhi Bug : This is sporadic pest and its incidence is generally low in most of the areas. Both the nymphs and adults suck the milky juice from the developing grains as a result the earheads become chaffy. Apply methylparathion 2% @ 10 kg per acre on the appearance of pest.

Grass Hoppers : The rice as well as the surface grasshoppers feed on the leaves in irregular manner throughout the crop season. The damage may be controlled by dusting the crop with methylparathion 2% @ 10 kg per acre.

Stem Borer : The incidence of rice stem borer is generally very low in most of the rice growing areas. In Basmati varieties, the attack is found to be moderate. The borer attack occurs from July to October. The attacked young plants show dead hearts while the older ones produce empty ear heads which remain white and stand erect.

The infested fields may be sprayed upon two times i.e. 50 and 70 days after transplanting with 500 ml of methyl parathion 50 EC or 500 ml monocrotophos 36 SL or 250 ml phosphamidon 85 SL or 1000 ml chlorpyriphos (Durmet/Lethal) 20 EC per acre in 200 litres of water per acre depending upon the age of the crop or apply 75 kg Cartap hydroch-

loride (Padan 4 G) per acre after mixing in 10 kg fine sand after 30 and 50 days of transplanting. This will take care of leaf folder also along with stem borer. In fields having more than 20 per cent stem borer incidence last year, apply 10 kg BHC 6% granules per acre in standing water twice (20 and 50 days after transplanting) in short duration varieties and thrice (20, 50 and 80 days after transplanting) in medium and long duration varieties.

Diseases

Foot Rot & Bakanae : Affected plants become lanky yellow and taller than healthy plants. Roots become black and rot and the ears from few and light grains.

Stem Rot : The disease appears at the earing stage. Lower portion of the plant becomes yellow, brown and rot, leading to collapse and lodging of the plant.

Brown Spot Disease : Small eye shaped or round spots are formed on the leaves. These spots are brown with grey or whitish centre. The disease occurs in the nursery also and the entire nursery may be affected by this disease, in case of serious attack. Affected grains become spotted and slightly shrivelled.

Blast : One or more spindle shaped spots with reddish violet margin and grey or whitish centres are formed on the leaves. These spots coalesce to form big lesions few inches in length and 1 cm in width. As a result of neck rot, i. e., infection at the base of panicle, half-filled or chaffy grains are formed and the earhead is usually dirty white in colour.

False Smut : Affected grains are quite big and swollen than the healthy grains in the panicle. Orange spore masses, which later turn black, become conspicuous when the affected grain bursts.

Bacterial Leaf Blight : Straw coloured lesions beginning from leaf tip on either side of the midrib progress downwards in wavy manner. Under severe conditions all the leaves get blighted. Bacterial exudate in the form of beds is noticed under humid conditions on the affected lamina. These beds are small and look yellow or wheatish in colour.

Bacterial Leaf Streak : Interveinal water soaked streaks are first noticed which turn yellow orange. Bacterial exudate appear on lesion under humid conditions which later dry.

Integrated Control Measures of the Diseases

1. **Selection of Seed** : Select only healthy seeds. Do not use seed from the fields which have been infested by the diseases in past years. Healthy, heavy and smut free seed should be selected according to the method given earlier in this chapter under seed treatment.

2. **Seed Treatment** : As already given under seed treatment.

3. **Spraying Operations** : (i) If the symptoms of brown spot disease are visible in the nursery, spray 0.2% solution of zineb.

   (ii) Spray twice Hinosan (200-225 ml/acre) or Bavistin 200-225 g/acre), or Beam (120 g/acre) from August or with first appearance of blast or brown leaf spot.

   (iii) For control of false smut, spray copper oxychloride @ 0.2% solution at root stage of the crop.

4. **Other Operations** : (i) The irrigation water from disease infested fields should not be allowed to go in the disease free fields, particularly from those fields which were affected by stem rot and bacterial leaf blight.

   (ii) The residues of crop affected by stem rot disease should be burnt immediately after harvesting the crop.

   (iii) Long crop rotation has proved very effective in controlling stem rot and false smut diseases.

   (iv) To minimise incidence of bacterial leaf blight, avoid early transplanting, application of heavy doses of nitrogen, closer spacing and stagnation of water.

CULTIVATION OF BASMATI RICE

Basmati rice occupies a special status for its aroma and excellent cooking and eating qualities It's rice gets premium in the market as its substantial quantity is exported. The present varieties are tall statured, photoperiod sensitive, which have lodging tendency under high input conditions. Basmati occupies 15–20% area of rice in the state, which depends on rainfall pattern of the season and the market rates prevailed during previous year. Moreover, about 80% area is covered in Karnal, Kurukshetra, Kaithal and Panipat while rest in the parts of Sirsa, Sonepat and Jind.

To obtain good yield of Basmati rice, the following cultural operations are recommended for adoption.

Climatic Requirement

Prolonged sunshine, high humidity and assured water supply are the prerequisites for Basmati crop. The fragrance, cooking and eating qualities of Basmati are improved, if the crop matures in relatively cooler temperature and does not suffer with any stress. The high temperature during grain filling reduces the quality traits of rice i. e. aroma, Kernel elongation and flackiness of cooked rice.

Rotation

Rice-wheat, rice-potato-wheat and rice-berseem crop rotations are followed in rice growing areas. Since Basmati crop is photosensitive and matures late as compared to other semi-dwarf varieties, rice-wheat/ sunflower sequence is the best suited for the cultivation of this rice. Addition of green manuring in summer season is helpful for soil health and fertilizer economy.

Variety

Basmati 370 : It is a tall statured (145 cm) indica variety and is famous for its quality rice. It does best on rice soils with plenty of irrigation but lodges under high level of nitrogen application. It is photo-period sensitive and takes 140-150 days from seed to seed. It is resistant to white backed plant hopper (WBPH) and stem-rot. Grains are partly awned. It has *superfine quality* of rice (long slender) which gives fragrance and elongates more than twice to their normal size on cooking without splitting. Average yield is 11 q per acre.

Haryana Basmati-1 : A short statured (116 cm) indica variety of *superfine quality* (long slender of rice). On cooking its kernels give fragrance, do not burst and stick together. It has good cooking and eating qualities. Takes 140 days from seed to seed. It is resistant to Blast, WBPH and moderately resistant to stem-rot and stem-borer. Its average yield is 16 q per acre.

Tarauri Basmati (HBC-19) : A tall statured (148 cm) and aromatic indica variety. It lodges under high fertility conditions. It is a photo-period sensitive strain and takes 145-155 days from seed to seed. It is resistant to white backed plant hopper (WBPH) and stem-rot. Its grains are extra long (7.1 mm), aromatic, and elongate twice without bursting on cooking. Its average yield is 10 q per acre.

Cultural Operations

Agronomic practices like land preparation, seed treatment, method of nursery raising, weed control etc. are the same for Basmati variety as for other semi-dwarf varieties. However, some of the practices, which require special attention are given below :

Seed Rate

Eight kg seed of good quality would be enough to raise the nursery for one acre field.

Time of Nursery Sowing

Basmati varieties are photosensitive and thermoinsensitive. Hence, it matures late. Therefore, nursery of these varieties may be sown in the 1st half of June for higher productivity and reducing blast disease incidence. Wet method of nursery raising has also been advised, which results in low incidence of blast.

Time of Transplanting

The time of transplanting is a crucial factor in determining the yield and quality of the scented paddy. Basmati varieties, if transplanted too early (by 30th June) in the season have a prolonged to vegetative phase, resulting in a taller and leafy crop. Such a crop is more prone to lodging, but have a escaping mechanism for blast disease. If the vegetative growth is excessive by early transplanting or other operations, the pruning of the crop at the canopy level of 60/70 cm after 55 days of transplanting will help to reduce the lodging without adversely affecting the yield. Therefore, optimum time of transplanting of Basmati rice is the 1st fortnight of July for higher productivity and low incidence of blast.

Age of Seedlings

Seedlings of Basmati rice are ready for transplanting when they gain 5 to 6 leaf stage or are 25 to 30 days old after sowing. Use of older age seedlings reduce tillering and yield of the crop.

Method of Transplanting

The seedbed should be irrigated a day prior to the uprooting of the seedlings. To remove mud, wash the seedlings gently in water simultaneously. Transplant 2-3 seedlings per hill in well puddled field with spacing of 20×15 cm during the optimum period. Under random

planting, uniformly distributed 35-40 hills/m^2 should be maintained. Seedling should not be transplanted more than 2-3 cm deep when the puddle settles.

Fertilizer Application

Fertilizers recommendations for Basmati rice

	Variety	Nutrients (kg/acre)			Fertilizer (kg/acre)			
		Nitrogen	Phos-phorus	Potash	Urea	SSP	Muriate of potash	Zinc sul-phate
1.	Dwarf Basmati	36	12	—	80	75	—	10
2.	Tall Basmati	24	12	—	50	75	—	10

Present Basmati varieties are not responsive to high dose of fertilizer. If soil test data is not available than apply above quantities of fertilizers per acre. Phosphorus need not be applied, if rice follows wheat, which received 25 kg P_2O_5/acre or if the soil test indicates high level of P, otherwise apply 75 kg of single super phosphate (SSPO). Broadcast urea in two equal splits. The first dose should be applied 3 weeks and the second 6 weeks after transplanting. Apply N fertiliser when water is not standing in the field or drain it out. Irrigate the field on 3rd day particularly after top dressing. In Haryana Basmati No. 1, give full dose of P, zinc and 1/3 of N at the time of transplanting. Remaining dose of N should be applied 3 weeks and 6 weeks after transplanting in two equal splits.

To avoid excessive vegetative growth in green manured field or early transplanted crop apply 2/3 of recommended dose of N & P, but provide full dose of Zinc sulphate. Zinc may be applied in the form of spray, if needed.

Irrigation

Withold water for few days (6-10 days) after transplanting when seedlings are established for development of better root system. In case of limited sypply of irrigation water, the field may be kept wet by repeated irrigations just before the soil reaches the saturation stage, the tillering and flowering stage. Stop impounding water about a fortnight before harvesting to facilitate easy field work.

PLANT PROTECTION MEASURES

1. Diseases

Among the diseases, blast *(Pyricularia oryzae)* poses serious threat to Basmati varieties. The disease causes spindle shaped spots with greyish centre and brown margin on the leaves at maximum tillering stage. It also causes black lesions at nodes and the neck of panicle leading to partial or complete blanking. For control of this disease, spray Bavistin @ 200 g or Hinosan @ 200 ml or Beam 120 g per acre in 200 litres of water at maximum tillering and once at ear emergence and again at 50% flowering stages. Early transplanting (between 1-15 July) and merged condition reduce the incidence of neck blast.

For the control of foot-rot/Bakanae and brown spot, the measures given in the dwarf rice cultivation should be followed.

2. Insect Pests

Basmati varieties are highly susceptible to leaf folder and moderately susceptible to stem-borer. Small, greenish and very active caterpillars of leaf folder scrap the green material of the folded leaves from inside during July to October. Spray 500 ml monocrotophos 36 SL or 400 ml quinalphos (Ekalux) 20 A. F. or 1 litre chlorpyriphos 20 EC or 500 ml methyl parathion 50 EC or 250 ml phosphamidon 85 SL or 350 ml endosulfan 35 EC in 200 litres water/acre or apply methyl-parathion 2% dust @ 10 kg/acre.

Caution : Phorate creates resurgence of leaf folder, hence these granules should not be used.

Infested fields of stem-borer may be sprayed upto 3 times i. e. 20, 50 and 80 days after transplanting with 500 ml of methylparathion 50 EC/monocrotophos 36 SL or 250 ml phosphamidon 85 WSC (Phosmidon) or 1000 ml chlorpyriphos (Durmet/Lethal) 20 EC per acre in 200 litres of water per acre depending upon the age of the crop. In fields having more than 20% stem-borer incidence, apply 10 kg BHC 6% granules/ acre in standing water.

Note : The above insecticides will also control leaf folder if it appears simultaneously in the field.

3. Harvesting & Threshing

Basmati rice varieties should be harvested as soon as the ears nearly ripe. Delayed harvesting may cause over ripening and shattering

of grains. The harvested crop should preferably be threshed on the same or next day of harvesting. The delayed threshing causes high shattering losses, reduced head rice recovery and ultimately reduces the market price of paddy.

HINTS FOR MAXIMISING RICE YIELD

1. Grow improved varieties suitable for different areas and fertility levels.

2. Treat the seed before sowing it in the nursery.

3. Raise healthy seedlings.

4. Proper time of transplanting and spacing are important along with the choice of varieties.

5. Apply balanced fertilizers viz., NPK at the proper time. Application of potash is essential to minimise the incidence of stem rot. Take care of zinc deficiency as soon as it is noticed.

6. Never allow the crop to suffer for want of adequate and frequent irrigations. Stagnation of water should, however, be avoided.

7. Do not let the weeds compete with crop.

8. Apply plant protection measures to keep down the insect pests and diseases.

BAJRA

Bajra is the principal **kharif** crop of Haryana. It contributes 70-90 per cent **kharif** production of rainfed areas, particularly Mahendragarh, Bhiwani, Gurgaon, Hisar, Rohtak and Jind districts. Because of its high yielding potential and its drought tolerance nature together with its utility as food, feed and fodder it shall continue to play a dominant role in the integrated agriculture and animal husbandry economy of the dry region of the state. Although its productivity has substantially increased after the release of high yielding hybrid varieties, yet there is a wide gap between the realised yield (3.6 q/acre) and the potential yield (16 q/acre) of the high yielding varieties. About 40% of the area is covered by the high yielding disease resistant varieties. The gap can be narrowed down by the widespread use of such varieties and adoptions of package of practices.

During the last 10 years, the area, production and average yield have been as under :

	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96
Area ('000 ha)	774	470	786	621	608	556	636	508	584	574
Production ('000 ton)	351	109	958	432	525	314	743	328	736	408
Average yield (kg/ha)	454	232	1219	696	863	565	1168	646	1260	711

Bajra production can be further increased by the spread of improved and disease resistant varieties and adoption of improved crop management practices.

AGRONOMIC PRACTICES

Soil and its Preparation

Bajra is grown on a wide range of soil types but it does best on sandy loam and well drained soils. It cannot withstand stagnation of water. Prepare a deep smooth and fine seed bed by giving two to three ploughings.

Sowing Time

Optimum sowing time for bajra is middle of July. However, in rainfed areas the sowing be done with the advent of monsoon. The sowing period can be advanced as early as first week of June in case sufficient showers of rain (50 mm) are received or irrigation facilities are available.

Seed Rate

1.5 to 2 kg of seed is enough to sow one acre so as to ensure 70000 number of young seedlings per acre.

Seed Treatment

Refer to under integrated plant protection measures.

Method of Sowing

Sow the seeds about 1.25 cm deep in uniform rows 45 cm apart or in paired rows 30 cm apart with 60 cm as interpair space. Plant to plant distance be kept as 12 cm. For getting good stand sowing may be done in paired rows on ridges with tractor drawn or bullock drawn ridger seeders. Basal dose of fertilizer should also be applied at the time of sowing with ridger seeders.

Thinning & Gap Filling

Establishment of proper stand is a problem in bajra. So thinning and gap filling by healthy seedlings after two to three weeks on any rainy day must be adopted as regular practice.

Transplanting in Bajra

Transplanting in bajra is not a substitute for direct sowing under normal sown conditions. However, under specific situations like delayed sowing or where continuous rains do not permit sowings, transplanting of bajra can be followed.

Nursery Management

Seed-bed for nursery should be selected near the source of water in case of failure of rains and on higher lands in rainy days. 600 g to 1 kg of seed be sown in an area of one kanal (27 M × 10 M) which would give sufficient seedlings to transplant one acre. Divide the nursery area into small beds. The nursery should be raised at least three weeks prior to actual tansplanting. In rainy days the seed should be broadcasted whereas in dry season it should be sown in closer lines. To check the attack of ants which remove the grains, BHC be dusted in the nursery. To give better start to seedlings nitrogen be applied @ 8-10 kg/acre of nursery at the time of sowing. Irrigation be given as and when required.

(i) **Age of Seedlings :** The best age of seedling for transplanting is three weeks. But four weeks old seedlings are equally good that have been taken from July 1 sown nurseries.

(ii) **Uprooting of Seedlings :** Care should be taken that the root injury is minimum at the time of uprooting. This can better be accompanied by wetting the plots at the time of uprooting the seedlings in case there is no rain. The top portion above the growing point should be removed so as to minimise the transpiration from the seedlings. Care be taken that the seedling affected with downy mildew be not transplanted and should be removed before hand.

Recommended Varieties/Hybrids

Sr. No.	Variety/Hybrid	Condition for which recommended	Growth habit	Maturity (days)	Productivity (q/acre) Grain	Dry fodder	Remarks
1	2	3	4	5	6	7	8
1.	HHB-50 (Hybrid) (MS 81A × H 90/4-5)	General cultivation both under rainfed and irrigated condition in the State	Medium tall, high tillering. dense earheads, medium bold grains	70–80	13	44	Highly resistant to downy mildew disease
2.	HHB-60 (Hybrid) (MS 81A × H 77/833-2)	-do-	Medium tall, high tillering, thin stem, narrow leaves, dense earheads & medium grains	74–76	13	44	-do-
3.	HHB-67 (Hybrid) (MS 843A × H 77/833-2)	-do-	Extra early maturity, escape drought, medium tall, high tillering, thin stem, medium broad leaves, dense earheads, medium bold grain size, suitable for inter	60–62	12.5	35	-do-

			and multiple cropping system, resistant to lodging				
4.	HHB-68 (Hybrid) (MS 842A × H77/833-2)	General cultivation both under rainfed and irrigated condition in the State	Extra early maturity, escape drought, medium height, thin stem, medium broad leaves, high tillering, dense earheads, medium bold grain size, suitable for intercropping	60–62	12.5	35	Resistant to downy mildew and less susceptible to smut and blast.
5.	HC-4 (Variety)	-do-	Tall, medium tillering, dense earheads, medium bold grain size	82–85	10	48	Highly resistant to downy mildew
6.	WC-C-75	-do-	-do-	82–85	9	44	-do-

Method of Transplanting

The field is prepared as usual. The transplanting should be done preferably on a rainy day. The seedlings are planted in rows of 45 cm apart keeping plant to plant distance of 12 cm. In the absence of rain, light irrigation be given to help the seedlings establishments. After 10 days of transplanting half dose of nitrogen be applied and if possible one hoeing should be done to incorporate the fertilizer and to make the soil loose for better aeration. Second half dose of nitrogen be applied at knee-high stage. Further care of crop be done as usual. Transplanted crop can be raised without any reduction in grain yield upto mid August. In transplanting process 8 labourers per acre are required.

Intercropping

The intercropping of legumenous crops like moong or guar with bajra can also be taken without any adverse effect on the grain yield of bajra. One row of moong or guar may be sown in between two rows of bajra spaced 60 cm apart. Intercropping of moong or guar in paired row planting system of bajra (30/60 cm) may also be sown for better yields of both crops.

Fertilizers

Under irrigated conditions, following doses of fertilizers may be applied in average soils. The dose may be reduced according to basic fertility of soil. The actual condition of the growing crop should be the best indication of the need for applying more fertilizers.

	Nutrients (kg/acre)		Fertilizers (kg/acre)			
	N	P_2O_5*	CAN (25%)	Urea (46%)	Super-phos-phate (16%)	Zinc-sulph-ate (21%)
Bajra hybrid (irrigated)	50	25	200	110	150	10
Bajra hybrid (rainfed)	16	8	65	35	50	—

*(i) In sandy soils apply full dose of phosphorus.

*(ii) If soil test indicates :

(a) available phosphorus in the soil is less than 2 kg/acre, then also apply full dose of phosphorus, or

(b) available phosphorus in the soil is between 2.5 to 4 kg/acre, then apply half the dose of phosphorus, or

(c) available phosphorus in the soil is 4.5 kg/acre or more, there is no need to apply phosphorus.

Half N and all P should be drilled at sowing with the help of ridger-seeder or seed-cum-fertilizer drills. Apply rest N in two split doses—one at thinning and the other at ear formation stage. In case Zinc Sulphate has not been applied in wheat crop in Bajra-Wheat-rotation, apply Zinc Sulphate @ 10 kg/acre at the time of sowing to irrigated bajra. For rainfed bajra add all the nutrients by drilling at the time of sowing and treat the seed with Azotobactor culture (Mac-68) under low fertility.

Interculture : Like other **kharif** crops weed control of bajra is a must. Interculture the crop three to five weeks after sowing. Avoid deep-hoeing near the plants because it damages roots and reduces the production. The interculture can be done either manually or by the bullock driven blade hoe and cycle wheel hoe (blade) for efficient and expeditious operation. These implements can be used after 15 days of sowing of a crop when the weeds are young and easily controllable. Use of these implements after every effective shower helps better conservation of moisture due to formation of dust soil mulch. Weeds can also be controlled with chemicals. Spray Atrazine (50 per cent) WP at the rate 400 g per acre in 250 litres of water immediately after sowing. This takes care of most of the weeds. If atrazine is not used pre-emergence, its post-emergence application @ 400 g/acre should be made within 7 to 15 days of sowing.

Irrigation and Drainage : Tillering, flowering and dough are three critical growth stages with regard to water stress.

Do not allow leaves to wilt at any stage of growth. The number of irrigations will depend upon rains. Generally, one or two irrigations are enough for raising a good crop. Bajra does not tolerate waterlogged conditions, therefore, after rains, do not allow the rain water to stand in the crop for more than a few hours. Sowing of bajra on ridges helps in better drainage of water.

Use of Brackish Water

One or two life saving irrigations with saline water of electrical conductivity (EC) upto 8000 micro-mhos/cm can be given to bajra crop after its establishment on sandy and loamy sand soils and upto EC 6000

micro-mhos/cm on sandy loam well drained soils, without any substantial reduction in its grain yield, in areas having at least 400 mm rainfall annually. For less rainfall areas, the EC limits should be reduced to half.

Transplanted bajra tolerates more sodicity (ESP) than seeded bajra and can be safely grown on soils having ESP upto 25, provided it is irrigated with canal or fresh water when need be.

Harvesting and Thrashing

Bajra crop is ready for harvest by the end of September or in October. Harvest the crop with the help of sickle at some height from the root zone and spread them in the field for drying or pick the matured ears and stock them to the thrashing field under cover. Thrash the produce with the help of bullocks or thrasher or drumy.

PLANT PROTECTION MEASURES

Insect pests and symptoms of attack	Control measures and precautions
1. **White grub :** Adults and light brown, brownish in colour. The beetles emerge from the soil after dust with the first shower of monsoon rain. They congregate and feed on the leaves of nearby trees. The beetle enters the soil before dawn. The grub is white in colour and "C" shaped. The white grubs with brownish mouth parts cut the roots of Bajra crop from August to October and cause heavy damage. Infested plants become yellow and ultimately dry. Sometimes this pest also damages the early crop of Bajra (if pre-monsoon rain occurs).	Adult beetles congragated on trees, first and second night after the monsoon showers should be collected by shaking the trees and killed in kerosenised water. This is the best method if carried out on campaign basis. Or To kill adult beetles, spray the trees grown in the field with 0.04% monocrotophos 36 SL or 0.05% quinalphos 25 EC or 0.15% carbaryl (Sevin/Hexavin) 50 WP on the same day or a day after the first shower.
2. **Hairy caterpillars** : The young caterpillars feed gregariously on the underside of the leaves and cause heavy damage by skeletonising the leaves. Grown-up	1. Do deep ploughing of the fields after harvesting of kharif crops to check the carry over of hairy caterpillars. The pupae get exposed and killed by predatory

caterpillars spread throughout the field and feed on the leaves. There are two species of hairy caterpillars found damaging the crop-Bihar hairy caterpillar and Red hairy caterpillar. Red hairy caterpillars remain active and cause damage from 2nd fortnight of July to end of August. Another species of hairy caterpillar causes heavy damage from August to October.

birds, mechanical injury or due to other reasons.

2. The moths of red hairy caterpillars are strongly attractive to artificial light. Use light traps at least for one month following the first shower of monsoon.

3. Destroy alternative host plants (weeds) on which the hairy caterpillars lay their eggs.

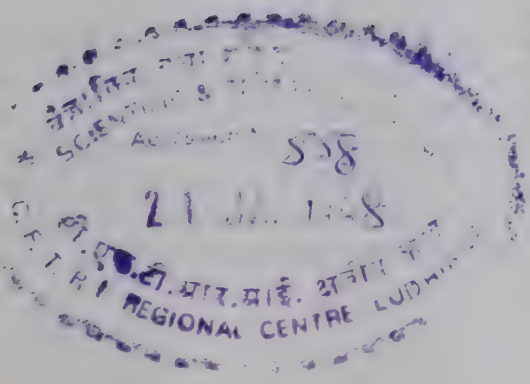
4. Destroy the egg masses of hairy caterpillars.

5. Infested leaves alongwith the young caterpillars should be plucked and destroyed either by putting them in kerosenized water or by burrying them deep in the soil.

6. Grown-up caterpillars should be destroyed by crushing them under feet or by picking and putting them in kerosenized water.

7. To kill young caterpillars, apply 10 kg BHC 10% dust per acre.

8. To kill grown-up caterpillars, spray 250 ml monocrotophos (Monocil/Nuvacron) 36 SL or 200 ml dichlorvos (Nuvan) 76 EC or 500 ml endosulfan (Thiodan/Thiotox/Endocel) 35 EC or 500 ml quinalphos (Ekalux) 25 EC in 250 litre of water per acre.



3. **Grey weevil :** The weevil is light grey in colour and causes damage by feeding from the margin of the leaves from August to October.	Spray 400 ml malathion 50 EC in 250 litre of water per acre, if the incidence is very high.
4. **Surface grasshopper :** It is dull brown in colour and moves by hops. Its damage is more pronounced in young crops.	In case of severe attack, use 10 kg BHC 10% dust per care.

Diseases

1. **Downy Mildew/Green Ear Disease :** Infected plants become stunted and unthrifty. Leaves become chlorotic or yellowish. The under-surface of diseased leaves is covered with white downy growth. The downy mildew infected crop looks yellowish from a distance. If infection of downy mildew occurs at seedling stage, premature drying of leaves and death of plants occur. In green-ear stage, the infected ears are malformed wholly or partially into small leaf like structures which remain green for longer period. In case of heavy infection there may be complete failure of the crop.

2. **Ergot** : Pinkish or light honey coloured, thick, fluid starts dropping from spikelets of the infected earhead. Later on, brown to dark coloured woody and pointed sclerotia appear on these spikelets in place of normal grains. The honey dew in the ergoty earhead and ergot sclerotia are poisonous to human as well as cattle due to the presence of toxic alkaloides.

3. **Smut** : In place of normal grains there appears large number of sori on the infected earhead. These sori are bigger in size, bright green in early stage, later on turning to chocolate brown, finally black due to the presence of millions of dirty black spore mass of the fungus.

Integrated Control Measures for the Diseases of Bajra

1. **Seed Treatment**

(a) The seed should be examined for the presence of ergot sclerotia. If the seed has been purchased from certified agencies the sclerotia should be removed by hand picking. If cultivators use their own seed, the removal of sclerotia can be done either by hand picking or by salt water floatation technique. In the salt water floatation technique seeds are dipped for 10 minutes in 10% common salt solution by thorough stirring. The

floating sclerotia should be skimmed-off and destroyed by burning. After salt solution treatment, the healthy seed should be washed thoroughly with clean water to get rid of salt deposited on the seed surface because presence of salt is harmful for seed germination. Finally, the seed should be dried in shade.

(b) After the removal of sclerotia, the dried seed should be treated with a mixture of 2 g Emisan and 4 g Thiram for one kg seeds.

2. **Roguing Downy Mildew Affected Seedlings** : Thorough roguing of downy mildew infected plants is to be done at pre-seeding stage. The rogued out plants should be destroyed and should not be brought in contact with the healthy plants. In case of moderate to heavy roguing the gap filling should be done with surplus healthy seedlings to maintain optimum plant population.

3. In case of susceptible variety, the crop should be sprayed with 0.2% zineb or mancozeb after roguing, at seedling stage.

4. **Adult Plant Spraying :** Spray the crop at boot stage with 400 ml Cuman-L diluted in about 200 litres of water per acre. Cuman-L reduces the ergot incidence.

5. **Eradication of Collateral Host of Ergot :** Blue-panic grass (*Panicum entidotale)* is also the host of bajra ergot fungus. Hence, it should not be allowed to grow near the bajra fields or deblossom during August-September.

6. **Other Disease Controlling Steps**

(a) Ergot affected ears with honey dew should be removed immediately on the symptoms appearance and should be destroyed by burning.

(b) Ergot affected crop should neither be fed to the cattle nor be preserved for human consumption.

(c) In case of severely affected area, 3-4 years crop rotation should be followed.

(d) Crop sown in the last week of June or first week of July contract comparatively less downy mildew and ergot diseases.

(e) During hot summer months invert the soil by deep ploughing with furrow turning plough so that ergot sclerotia and downy mildew oospores get burried deep in the soil.

(f) Ergot infected grains should be washed thoroughly to remove toxic alkaloids before consumption.

HINTS FOR MAXIMISING YIELD

(i) Obtain fresh seed of hybrid bajra every year from trusted agencies.

(ii) Sow the crop in time, i. e., at the onset of monsoon in unirrigated areas and mid of July in irrigated areas.

(iii) Sow the seed after proper treatment.

(iv) Sow the seed at proper depth and in optimum moist seed-bed to ensure good germination.

(v) Apply recommended doses of fertilizer.

(vi) Transplant spare seedlings after 3 weeks in patchy fields to keep uniform optimum plant population.

(vii) Adopt timely plant protection measures.

MAIZE

Maize is mainly grown in the districts of Ambala, Kuruskhetra and Karnal as a cereal and industrial crop. It needs well drained deep soil as it is sensitive to standing water. Area and production under this crop in Haryana during the last decade is as under :

	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91
Area ('000 ha)	69	56	59	61	55	53	36	42	38	33
Production ('000 ton)	78	56	70	79	69	66	31	39	54	47
Average yield (kg/ha)	1048	1001	1190	1303	1246	1250	859	920	1434	1436

More production could be achieved through selection of improved varieties adopting improved agronomic practices and plant protection measures.

IMPROVED VARIETIES

The following varieties are recommended on the basis of their suitability for different regions of the State :

Recommended varieties	Region	Rainfall
Ganga–5, Vijay and Ageti–76	Ambala, Kuruskhetra, Karnal, Rohtak, Hisar, Gurgaon and Jind	50–57 cm irrigation is needed in regions with below 50 cm rainfall

Ganga Hybrid 5 : It matures in 95 to 100 days. It is resistant to leaf blight and brown stripe downy mildew. Plants are vigorous and sturdy with medium height. Bears thick cylindrical ears with yellow flint to semi–flint grains. It gives an average yield of 16 q/acre.

Composite Vijay : It matures in 95–100 days, has vigorous plants with broad, dark–green leaves. It is tall, resistant to lodging, leaf blight and has tendency to bear two ears per plant. Grains are medium bold, semi–flint and yellow to orange colour. Gives an average yield of 16 q/acre.

Ageti–76 : It matures in 85–88 days. It has medium thick and strong stem. Leaves are darker than the Vijay Composite. Ears are long, cylindrical with medium tight husk cover. Grains are medium round, orange yellow and mostly flint. It has good level of resistance to the major diseases and borer. Gives an average yield of 15 q/acre.

Maintenance of Seed of Composite Varieties

The farmer can raise his own seed of composite varieties like 'Vijay' unlike the hybird varieties where he is required to buy fresh seed every year. To maintain purity and production potential of the composite varieties farmer may take care of the following factors :

1. Avoid mechanical mixture.

2. Avoid natural cross pollination with any other maize variety or hybrid grown in the nearby fields. Cross pollination can be effectively checked by isolating the composite from other maize fields by about 200 to 300 metres in all directions.

3. Seed should invariably be kept from large maize fields or say at least 2.5-5 ha. This is necessary to ensure yield potential of the crop.

4. Always take large number of best cobs from the middle of the plot i. e. not less than 2,000 to 5000 and mix the grains of all the selected cobs for the seed required for next sowing. Even if seed requirement is small never bulk less than 2,000 cobs.

Preparatory Tillage

It requires adequate ploughing to a depth of atleast 12-15 cm in such a way as to turn under organic matter, crop refuse, green manure or compost. One such ploughing with a mould-board plough is all that is required, This should be followed by enough surface cultivations (four harrowings and six plankings) to have a good seed-bed, free of any weed or clods to receive the seed.

Sowing Time

Irrigated conditions	25th June to 20th July
Rainfed conditions	With outbreak of monsoon

The recommendations on sowing time cannot be very rigid. It depends upon varying conditions of weather, onset of monsoon rainfall, etc. However, the above schedule is likely to give in general good results.

Seed Treatment

Sow only treated seed for the control of soil and seed-borne diseases using Thiram @ 4 g/kg seed.

Method of Sowing and Seed Rate

Efforts should be made to have approximately 20,000 plants per acre at maturity. Under some conditions it may be necessary to use somewhat heavier rate and thin to the desired stand when the plants are 3-4 weeks old. Seed should be sown between 3 to 5 cm deep but not deeper than 5 cm with sufficient soil moisture to bring quicker and proper germination. Generally, 7 kg seed per acre is required. Planters should be preferred for sowing.

Maize must be sown in lines. The following row and plant spacings are recommended under normal fertility conditions :

Variety	Spacing		Plant population/ acre at maturity	Remarks
	Between lines	Between plants		
Ganga-5, Vijay and Ageti-76	75 cm	22 cm	21,000	Plant 15% more to compensate plant loss.

The results of the trials conducted on plant population and nitrogen levels have shown that under high fertility conditions it may be desirable to plant them at the row to row and plant to plant spacings of 75 cm and 20 cm, respectively, giving about 26,000 plants per acre. In this case, 8.5 kg seed per acre would be required to have this population. The recommendation of high plant population than usually recommended (20,000 plants/acre) is of importance in light of the fact that generally farmers find it difficult to maintain proper stand and are not able to get high yield which is possible from the hybrid and composite varieties.

Fertilizers

The following quantities of different fertilizers are recommended for average soil conditions :

Nutrients (kg/acre)			Fertilizers (kg/acre)				
N	P_2O_5	K_2O	CAN 25%	Urea	Super-phos-phate (16%)	Muriate of potash (60%)	Zinc sulphate (21%)
60	25	25	240	130	150	40	10

Drill all P and K and 1/3 N at sowing. Apply one-third N as top dressing when plants are at knee height and remaining one-third N at pre-tasselling stage. Zinc sulphate may be drilled at the rate of 10 kg/acre at the time of sowing. Spraying the crop with zinc sulphate has been found to be as effective as soil application. However,

three sprayings (0.5% zinc sulphate plus 0.25% slaked lime) can be done, if necessary. The first spray could be given one month after sowing and the remaining two at 10-day intervals.

Interculture

Weeds if not controlled may reduce the yield even upto 50 per cent or more. These should never be allowed to grow for fodder purposes. Weeds may be controlled with a cultivator, wheel hand hoe, hand pulling or chemical means.

Chemical Weed Control : Weeds like **Itcit** *(Trianthema monogyna)*, **Chaulai** *(Amaranthus* spp.*)*, **Bakhra** *(Tribullus terrestris)*, **Bichkopra** *(Boerhavia diffusa)*, **Jangli Jute** *(Corchorus acutangulus)*, **Dudhi** *(Euphorbia* spp.*)*, **Hulhul** *(Gynandiropsis pentaphylla)*, **Nunia** *(Portulaca quadrifida)*, **Swank** *(Echinocloa colonum)*, **Makra** *(Dactyloctenium aegyptium)*, associated with maize crop can be controlled by pre-emergence application of 400-600 gram. Simazine (50% WP) or Atrazine (50% WP) per acre in 200-250 litres of water immediately after sowing of maize. Lower doses of herbicides should be used in light soil and higher doses in case of medium to heavy soil. If Atrazine (50% WP) is not used as pre-emergence, its application @ 400 g/acre in 250 litres of water should be made from 7 to 15 days after sowing.

Irrigation and Drainage

For attaining the highest production potential, adequate water supply during the rain-free period is essential particularly during flowering and grain-filling period. It has also been found that tasselling is the most critical stage for soil moisture. Hence, an irrigation at this time is essential.

Maize is not only sensitive to soil moisture stress but also is adversely affected due to excess soil moisture conditions, particularly during the vegetative stage of growth. It is, therefore, recommended that furrow irrigation should be practised in areas with poor drainage or heavy rainfall. Besides water economy, the ridges help the plant from being stagnated during heavy monsoon.

Furrow Method of Irrigation : Furrows are like small irrigation channels between the crop rows. Water enters into the soils and spreads out into the crop zone between furrows. Furrows are made with various cultivating tools, such as furrower, blade harrows, and double mouldboard plough. Furrow spacings are usually the same as crop spacing so that furrows alternate with crop rows.

Furrow irrigation is adaptable to a great variation in land slopes and soil textures. On sloping fields, contour furrows save excessive costs in land levelling. With contour furrow irrigation water is carried across a sloping field rather than down the slope. The furrows have sufficient grade ranges from 0.05 per cent upto 0.5 per cent. It is better to keep the furrow slope within the range of 0.2-0.5 per cent.

Furrow Stream : At the beginning of irrigation the largest stream of water that will not cause erosion is used in each furrow. When the initial stream reaches the lower end of a furrow, the stream is usually reduced of 'cut back' to one that will just keep the furrows wet throughout its length with a minimum waste at the end. This 'cut back' stream flows until the required amount of water is applied. The size of the cut back stream and time of application depends on the intake rate of furrows and depth of water to be applied to bring the root zone moisture upto field capacity.

Length of Furrows : From the preliminary field, the following lengths are recommended to the three soil groups :

Soil type	Length of furrow
Light	80–125 metres
Medium	120–200 metres
Heavy	180–300 metres

Harvesting and Thrashing

The crop is ready for harvest even when the stalks and leaves are still somewhat green though the husk covers have dried and turned brown. Harvest the cobs in the field from the standing crop, dry, shell and market the produce at 15 per cent moisture. Partially green stalks can be fed to cattle as fodder. Another method is to harvest the stalks on maturity, stock in small bundles and separate the cobs, after sowing of wheat following maize. Thrashing can be done by power maize sheller or hand driven maize shellers.

Storage

In order to prevent grain losses during storage, metal sheet bins of various capacity are recommended. The airtight bin is so constructed that it does not allow entry of any outside insect and the microorganisms

present in the grain do not get the atmosphere to develop and are killed eventually themselves. It is economical, portable and simple to fabricate.

While filling and using the grain bin, the storage practices, given as under, are recommended :

1. Clean the bin thoroughly and do not allow the left over of previously stored grain to remain in the bin.

2. Clean and sort the grain of all the impurities which lead to insect attraction. These should be separated.

3. Do not mix the new grains with old stock as the later may be infested with insects.

4. Never store high moisture grain. Dry the grain in the sun, cool it and fill in the bin later in the evening. The moisture content of the grain should not be higher than 10%.

PLANT PROTECTION MEASURES

Insect pests and symptoms	**Control measures and precautions**
Stem borer : It is a serious pest of maize. It starts attacking the crop immediately after germination. Its damage is more during the months of June to September. It causes dead hearts in young plants. In older plants, it cut holes in the central leaves and also feed from the margins of the leaves. The larvae bore into the stalk and make tunnels and reduce the yield to a considerable extent.	For its effective control, spray the crop four times, starting 10 days after germination as per schedule given below : i) First spray 10 days after germination, use 200 g carbaryl (Sevin/Hexavin/Carbavin) 50 WP or 250 ml endosulfan (Thiodan/Thiotox/Endocel) 35 EC in 250 litres of water per acre. ii) For second spray 20 days after germination, use 300 g carbaryl 50 WP or 375 ml endosulfan 35 EC in 300 litres of water per acre. iii) Third spray, 30 days after germination, use 400 g carbaryl 50 WP or 500 ml endosulfan

35 EC in 400 litres of water per acre.

Note : Spray should be directed to the leaf whorl.

Surface grass hopper : It is dull brown in colour and moves by hops. Its damage is more pronounced in young crop.

Army worm : It is a sporadic pest. Its infestation is often more during the months of September-October. Young larvae feed on the plant whorl, while grown up caterpillars feed on other leaves and skeletonise them. In infested fields, its faecal matter is often seen.

Hairy-caterpillars : The young caterpillars feed gregariously from the underside of the leaves and cause heavy damage by skeletonising them. The grown up caterpillars spread throughout the field and feed on the leaves.

1. For young hairy-caterpillars, surface grasshopper and armyworm, use 10 kg BHC 10% dust per acre.

2. Since young larvae of hairy caterpillars are found congregated on the leaves, such leaves should be plucked and destroyed.

3. Destroy the egg masses of hairy caterpillars.

4. Grown up caterpillars should be destroyed by crushing them under feet or by picking and puffing them in kerosenised water.

5. To kill grown-up caterpillars, spray 250 ml monocrotophos (Monocil/Nuvacron) 36 SL or 200 ml dichlorvos (Nuvan) 76 EC or 500 ml endosulfan (Thiodon/Thiotox/Endocel) 35 EC or 500 ml quinalphos (Ekalux) 25 EC in 250 litres of water per acre.

Grey weevil : The weevil is grey in colour and causes damage by feeding from margins of the leaves from August to October.

If incidence is very high, use 400 ml malathion 50 EC in 250 litres of water per acre.

Thrips : Brown coloured thrips cause damage by sucking sap from the leaves of young plants

For thrips and jassid control, spray 250 ml malathion 50 EC in 250 litres of water per acre.

during the months of April to June.

Jassids : Green coloured nymphs and adults cause damage by sucking sap from the undersides of the leaves during the months of April to July.

For the control of birds on maize, see Appendix VI.

Note : Maize plants treated with malathion and carbaryl should not be fed to cattle for one week and those treated with other insecticides for three weeks.

Diseases

1. **Seed Rot and Seeding Blight :** Reduce seed germination and emergence due to depth of seed and seedlings.

2. **Pythium Stalk Rot** : Affects only a portion of one of the three or four basal internodes which is enough to topple the plants. Such toppled plants continue to live for some time while fluffy cottony mycelial growth develops on lesions.

3. **Bacterial Stalk Rot** : The basal internodes become soft and discoloured and stalks appear as if boiled in water. Leaves begin to wilt and affected plants lodge. Mild sweet fermenting odour accompanies rotting.

4. **Leaf Blight :** Diseased leaves show grayish, tan, parallel or straight sided or diamond shaped 1-4 cm long lesions surrounded by yellowish green halos.

5. **Downy Mildew :** Yellowish streaks, later turning brown, or complete chlorosis of foliage accompanied with whitish downy growth if examined in early morning.

Integrated Control Measures of Diseases

1. **Seed Treatment** : Treat seed with **Thiram** @ 4 g/kg seed.

2. Drench the soil at the base of plants with Captan (150 g) and stable bleaching powder (33 g) in 100 litres of water when the crop is 5-7 weeks old.

3. To control leaf blight and other foliar diseases spray zineb or mancozeb (1 kg/acre) when the crop is at knee-high stage. Repeat at 10-15 days interval if required.

4. Avoid water-logging and high plant population.

5. Plant the crop between 10th and 20th July.

6. Practise roguing of plants with affected stalk when crop is 5-7 weeks old.

HOW TO MAXIMISE MAIZE YIELD

(i) Procure seed of the hybrid or composite variety, fertilizer and pesticides well in advance of sowing season.

(ii) Select the right hybrid or composite seeds for your area.

(iii) Get fresh hybrid seeds every year.

(iv) Raise your own composite maize seed by selecting 2 to 5 thousand cobs from the central portion of the fields.

(v) Do not use seed from a few cobs of a composite variety.

(vi) Use proper seed rate to insure a good crop stand. Corn planter may be used for sowing.

(vii) Apply the recommended doses of fertilizers.

(viii) Keep the weeds off the field.

(ix) Control maize borer by using proper insecticides.

DESI MAIZE

Desi maize varieties constitute two groups depending upon their maturity :

1. Desi maize which ripens in about 80 days.

2. Sathi maize which ripens in about 65 days.

Sowing Time

Desi maize	June to July
Sathi maize	March to April

Seed Rate

Desi maize	6 kg/acre
Sathi maize	8 kg/acre

Recommended Spacings

Desi maize	Row to row	37-45 cm
	Plant to plant	15-22 cm
Sathi maize	Row to row	30-37 cm
	Plant to plant	15 cm

Fertilization

Nutrients (kg/acre)			Fertilizers (kg/acre)			
N	P_2O_5	K_2O*	CAN (25%)	Urea	Super-phosphate (16%)	Muriate of potash (60%)
25	12	12	100	55	75	20

*Apply after soil test.

Drill all P and K and 1/2 N at sowing. Apply remaining N one month after sowing as side-dressing.

If zinc sulphate was not applied in the previous crop, drill 10 kg zinc sulphate per acre at the time of sowing. It can also be sprayed, in case zinc sulphate has not been applied at sowing time. For this, three sprays (0.5% zinc sulphate+0.25 slaked lime) should be done. First spray after one month of sowing and the remaining two may be applied at 10-day interval.

Note : Other recommendations with regard to agronomic practices and control of insect pests and diseases are the same as for the other improved varieties of maize or hybrid maize.

CASH CROPS
(COTTON, SUGARCANE AND GUAR)

COTTON

Cotton is an important **kharif** cash crop and grown over an area of about 537 thousand hectares in Haryana. Though the average yield, 10 q per hectare, in the State is about thrice the national average yet there is a vast scope for improvement. Some of the progressive farmers have achieved 25 to 30 q/ha by practising the recommended cultural practices. Thus, cotton production can further be increased by adopting the latest improved cultural practices. During the last one decade the area and production under cotton has been as follows :

	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96
Area ('000 ha)	319	417	433	468	495	509	533	563	557	646
Production ('000 bales*)	404	690	845	1183	1000	1350	1411	1124	1373	1283
Average yield (kg/ha)	901	281	332	430	343	451	450	339	419	338

*One bale=170 kg

Sowing of suitable variety at appropriate time, better germination, judicious fertilization and timely plant protection measures are a must for getting higher production of cotton.

IMPROVED VARIETIES

The recommended varieties for different agro-climatic regions, their characteristics and economic features are given below :

H-777 : This variety is a reselection from Bikaneri Narma and was released for commercial planting during 1978. It has been recommended for sowing in cotton tract of Haryana lying in the west of Hisar. The variety attains a height of 120 cm to 150 cm and possesses 3-6 string monopodial branches. Leaves are medium in size, stems and leaves covered with hairy flowers cream and pollen cream in colour.

Bolls are medium in size and oblong with pointed tip. It matures in 180-190 days and earlier in maturity by 7-10 days than its parental variety Bikaneri Narma. It yields 7.5 q/acre. Its mean fibre length is 22 mm and possesses lint per cent of 34.6. Because of its jassid resistance and capability to escape pink boll worm by virtue of its early maturity, it will need lesser plant protection measures. The variety being early will fit in double cropping pattern.

HS-45 : This variety was recommended in 1988 for cultivation throughout the Haryana State for early sowing (upto 15th May). It matures in 180 to 190 days with a good fluffy opening of bolls. It vacates the fields in the month of November for timely sowing of wheat crop. This variety attains a height of 120 to 160 cm and possesses 2-5 strong monopodial branches. Resistant to jassids being early in maturity and synchronous in flowering, it escapes from the damage of pink bollworm considerably. Its average yield is 8.4 q/acre with mean fibre length of 22.5 mm and ginning percentage of 34.

HS-6 : Variety HS-6 is recommended for cultivation in whole of the Haryana State for early and normal planting i. e. from 15 April to 15 May. This variety outyielded the check H-777 by a margin of 15.8%. The highest yield obtained by this variety is 4100 kg/ha. However, the average yield is 2163 kg/ha. The plant is upright with 2-3 strong monopodes, hairy, medium size, light green leaves, big round bolls, cream flower and fluffy boll opening. This variety matures in 180 to 185 days. Disease & jassid incidence is at par with other varieties, however, boll worm infestation is comparatively less in this variety. Being synchronous in flowering and boll opening, less number of picking are required. 35% lint and 23.5 mm mean fibre length are the main fibre character of this variety.

H-974 : Variety H-974 is recommended for cultivation in whole of the Haryana State for normal and late planting i.e. from 15 May to 10 June. The margin of superiority of H-974 over H-777 is 16.8%. The highest yield obtained from this variety is 3664 kg/ha and the average yield obtained is 1860 kg/ha. The plant of this variety is bushy with 2-3 strong monopodes, big pointed bolls, hairy, green cup shaped leaves and medium to broad in size, flower colour cream with creamy pollen, and fluffy boll opening. This variety is having field resistance to diseases and insect pest. The maturity period of this variety is 170 days. H-974 is superior in fibre length 24.00 mm and lint (35.2%).

H-1098 : The latest American cotton variety released in the end of year 1995 by State Variety Released Committee is higher yielder with an average yield of 2100 kg/ha. The variety is early maturing with 165-170

days crop duration with 35.5 ginning out-turn and its fibre length is 23.0 mm. This variety is suitable for late sowing.

Dhan Laxami (HHH-81) : The very first intra hirsutum cotton hybrid also, known as Dhan-Laxmi was released in 1994 by the State Variety Release Committee for commercial cultivation in the State. Its yielding potential is 47 q/ha and average yield is 2451 kg/ha with 35.5 per cent ginning out-turn, 26.8 mm fibre length and suitable for spinning at 40's counts. Its plant is 180 cm tall with 3-4 strong monopodial branches, green leaves, hairy surface, cream corolla and yellow pollen colour and pointed apex of boll. It is fairly resistant to insect pests and diseases. The crop duration is of 180-190 days.

HD-107 : The latest desi cotton variety released in 1994 by the State Variety Release Committee is higher yielder over all the old desi cotton varieties i. e. DS-1 and DS-5. Its yielding potential is 35 q/ha with 38 per cent ginning outturn. However, its average yield per hectare is reported as 25 q/ha and its fibre length is 18.6 mm. Its crop duration is 180 days, last picking is over by end of October. HD-107 attains 150 cm height, semi-determinate growing habit with 2-3 monopodia and 20-30 sympodia. Green leaves have deep cut. Corolla colour is cream with red-eye at the base and yellow pollen colour. Resistant to jassids and tolerate to boll worms, suitable for normal planting, can tolerate drought conditions, lodging resistance and responsive to fertilizer. It possesses short and coarse fibre suitable for non-spinnable consumption.

DS-5 : This variety was recommended for general cultivation in Haryana State in 1987. It is a desi cotton variety with green plant body. several monopodia at the base, leaves medium in size, 3 to 5 lobes, flower white in colour with dark red coloured petal spot, yellow pollen and medium size bolls with good fluffy opening. It requires less number of pickings due to non-shedding of kapas. Its average yield is 8.3 q/acre. The lint is boared and thus suitable for export purposes, mean fibre length is 16 mm and lint percentage is 40. It matures in 165 to 175 days and thus fits well in cotton-wheat rotation. It is moderately resistant to spotted bollworms and it escapes pink bollworm incidence considerably due to its early maturity.

AGRONOMIC PRACTICES

Rotations : Grow cotton after wheat, gram, berseem, methi or fallow. More production can be obtained by applying higher doses of fertilizer in case cotton is grown after wheat.

Soil and its Preparation : Cotton can be successfully grown on all types of soil except purely sandy, saline or waterlogged soils. Land should be thoroughly prepared. Three to four ploughings will suffice to get proper tilth. Deep ploughing is desirable for high yields. Use of soil turning plough for the first ploughing after the harvest of the previous crop is recommended. For good preparation of seed-bed two ploughings each followed by planking to pulverise the soil after a heavy **rauni** (first irrigation given for sowing) are necessary. A fine seedbed is essential for securing good crop stand.

Sowing time : Optimum time of sowing of cotton is entire month of May except in areas in districts of M/garh, Bhiwani and Dabwali (Sirsa) where soils are light and drifting sand is problem. Sowing should be done in the first fortnight of April to avoid burning and burying of young seedlings due to sand drifting.

Seed Rate

Variety	Delinted and graded seed (kg/acre)	Undelinted and sound seed (kg/acre)
H-777, HS-45 H 974, HS-6, H-1098	6-8	8-10
Hybrid HHH-81 (Dhan Laxmi)	—	—
HD 107 and DS 5	1.20-1.50	5

Note : 1. If the delinted seeds of cotton are not available for sowing with drill, then the seed should be rubbed with fine soil, dung or ash so that the drill could deliver the seed uniformly in the soil.

2. For the control of the larvae of pink boll worm, a seed borne disease seed should be treated with fumigants in the factories.

Seed Treatment

To obtain robust and healthy seedlings, soak the seed thoroughly for 6-8 hours for fuzzy seeds and 2 hours for delinted seeds.

Emisan	=	5 g
Streptocycline	=	1 g
Succinic acid	=	1 g
Water	=	10 litre
Cotton seed	=	5-6 kg fuzzy seed 6-8 kg delinted seed

In areas where termite is a problem, after the above treatment, treat the seed with chloripyriphos @ 10 ml/kg seed with equal amount of water. Shade dry the seed and mix the insecticide and water and pour the mixture and mix the seed.

For the control of root rot, after the above fungicidal treatment, treat the seed after shade drying with carbendazim (Bavistin) @ 2.5 g/kg seed as dry seed treatment. In the standing crop with the first appearance of the disease, the affected plants may be removed and soil may be drenched with 0.2 per cent carbendazim.

The fungicidal treatment will both ward off from soil and seed borne infection for a period of atleast 40-50 days.

The succinic acid makes the seedlings robust and healthy, accelerates root growth whereby absorption from the soil is facilitated under droughty conditions.

Acid-delinting of Ginned Cotton Seed

The process of removing fuzz off the ginned cotton seed by treating with conce. sulphuric acid is known as 'acid delinting' Acid-delinted cotton seed is easily sown by seed drills/planters which would otherwise clog the seeding tubes etc. and thus good germination and crop stand is established. In acid-delinted cotton seed, healthier and viable seeds are easily separated from the important light seeds during the process of acid washing in water still. So even if the seed is sown by the traditional method, good germination and crop stand can be achieved. Besides, it economizes the seed rate.

Acid-delinting Process : In the process of acid-delinting a fixed quantity of cotton seed is thoroughly mixed with a proportionate quantity of conce. sulphuric acid (H_2SO_4) for specified period of time. Quantity of sulphuric acid (Industrial grade) ranges from 70 C. C. to 100 C. C. per kg of fuzzy seed and time of mixing varies from 6 to 12 minutes, both depending on variety of cotton seed. During the process, all the fuzz is burnt. Then the seeds are thoroughly washed atleast thrice in clean water. The seeds, thus, obtained are floated in sufficient water so that immature and lighter seeds are removed and discarded. Healthy seeds are again washed in lime water to neutralize the residual effect of sulphuric acid. Then, these are dried in the sun and subsequently sown.

Details of Acid-Delinting Process are as follows :

Particulars	Fuzz on cotton seed		
	High	Medium	Lower
Sulphuric acid required for one kg of fuzzy seed (ml)	100	80	70
Time of mixing (Minutes)	12	8	6
Slaked lime required for one kg of fuzzy seed (g)	20	20	20
Minimum drying time (h)	4	4	4
Delinting cost (per kg of fuzzy seed)	—	80-90 Paise	—

Equipment for Acid-Delinting : Suitable equipment of varying capacities have been designed for carrying out the acid-delinting safely. First is the Hand Operated Delinter whose capacity is to delint 4-5 kg of fuzzy cotton seed per hour. It is suitable for small farmers. It costs Rs. 700/- (approx.). Second is Commercial Grade Delinter whose capacity is 50-100 kg per hour. It is suitable for large scale acid-delinting of cotton seed. It costs about Rs. 2000/-. A small model of Commercial Grade Delinter has also been developed which is suitable for average and medium farmers. Its capacity is 25-50 kg per hour and cost Rs. 1500/-. Besides, Acid-Delinting Plant has been developed by which acid-delinting can by carried out conveniently.

Cotton seed can be acid delinted even if the equipments as mentioned above are not available. For this, plastic bucket can be effectively used. Take about 1 kg of cotton seed in a plastic bucket and add proportionate quantity of sulphuric acid into it. Stir the seed and acid with the help of a wooden stick till whole of the fuzz is burnt. Now wash the seed thoroughly in water and separate the healthy and viable seed from the light impotent seed which will float in water.

Precautions : Care be taken to see that sulphuric acid does not touch any part of the body. For safety, use hand gloves, goggles and rubber shoes. The acid contaminated water should be disposed off to some safe place beyound the reach of animals. In case, sulphuric acid affects any part of the body some anti-burn ointment should be applied or the affected part of the body should be immediately put in the lime water.

Method of Sowing

Sow cotton with seed-cum-fertilizer drill/planter or with single row cotton drill at the following distances. The seed should be sown at a depth of 4-5 cm.

Variety	Line to line distance (cm)	Plant to plant distanee (cm)	Number of plants after thinning (per care)
H-777/ HD 107	67.5	20-30	20,000
HHH-81	67.5	60.0	—

If sowing is delayed, the plant to plant distance should be reduced and seed rate be increased. Thinning may also be minimized.

Direction of Lines

Cotton sown in lines in the eastern to western direction gives comparatively higher yield than that sown in northern-southern direction. This is very good method of getting more cotton.

Thinning

Thin out the extra and weak plants two to three weeks after sowing keeping their recommended distance between the plants within the row. Keep one plant per hill. Thinning should be done before first irrigation. Remove off-type plants.

Fertilization

Cotton responds very well to the application of nitrogenous fertilizers. In certain areas, however, the crop has shown some response to the application of phosphatic fertilizers also. The following fertilizer recommendations are made for increasing the yield of the crop.

Varieties	Nutrient (kg/acre)		Potash	Fertilizer (kg/acre)				
	Nitro-gen	Phos-phorus		CAN 25%	Urea 46%	Super phos-phate (16%)	Muriate of potash	Zinc sul-phate (21%)
American cotton	35	12	—	140	76	75	40	10
Hybrid cotton	70	24	24	280	150	150	—	49
Desi cotton	20	—	—	80	45	—	—	—

Drill entire phosphorus preferably at sowing time and if not then it may be drilled at square formation stage. Apply half N at square formation and remaining half N at commencement of flowering. For uniform application of urea fertilizer broadcaster may be used. When cotton follows wheat or the soil is poor the first half dose of N may be applied at sowing time instead of square formation stage. Zinc sulphate should be applied at sowing time. In hybrid cotton apply nitrogen three times, take 1/3 at sowing, 1/3 at square formation and 1/3 at flowering stage. Basal dose of fertilizers may be applied with a seed-cum-fertilizer drill.

Foliar Application of Urea

Out of the above dose of nitrogen 8 kg N per acre, spray through foliar application of urea is beneficial for increasing the production. It can be mixed with insecticides also and spray at the time of flowering and boll formation. The urea should be sprayed at a concentration of 2.5% in case of hand operated sprayer and 8-10% in case of motorised sprayer.

Interculture

Two to three hoeings should be done. First with **Kasola**/wheel hand hoe before first irrigation for dry hoeing weed control and subsequent hoeings may be done with adjustable cultivator/lister plough after every irrigation/rain.

Weed Control

According to the results the normal interculture is the best method for the control of weeds. However, the weedicide treatments, (i) Diuron 200 gm + gramaxone 600 ml/acre (product) post emergence application together with one dry hoeing or (ii) Basalin 800 ml (product) pre planting applicatian with 200 litres of water per acre and incorporation in the top most soil, have given almost same yield as normal, intercultures. (iii) The pre-emergence application of Pendimethalin (Stomp 30) @ 2 kg/acre (product) is recommended for efficient weed control of **Santhi** and **Sanwak**. These weedicide treatments obviously have kept the weeds under control and can be used particularly under the situations, when labour is scarce and costly, or when the soil continues to remain wet and cannot be worked because of incessant or off and on rains and secondly where the weeds like **Trianthma monogyna** is the problem. (iv) Trifluralin applied pre-plant incorporation at 800 ml (product)/acre followed by one hoeing at 45 DAS or trifluralin 800 ml (product)/acre applied immediately after one dry hoeing (40 DAS) followed by irrigation provide effective control of annual grasses and broad leaf weeds.

Ridging in Cotton

Economy in irrigation water may be brought about by modifying the irrigation system. Furrows are made in between the rows of standing cotton during the course of interculture and irrigation applied in furrows, which results in saving of water to the extent of 25-30 per cent as compared to flooding, without causing any loss in yield. The nutrients are efficiently utilized. With this practice of ridging during the course of interculture, under light irrigation, water remains available to the plants for longer time, and in the event of heavy rain, water is drained out easily and the plants being on ridges, are saved from the effect of waterlogging. It also controls weeds effectively. Ridges can be made with the ridger.

Irrigation

Cotton crop requires three to four irrigations depending upon the seasonal rainfall. First irrigation should be delayed as much as possible without causing any injury to the crop. Subsequent irrigations should be given at two to three weeks interval. The crop must not be allowed to suffer for water stress during flowering and fruiting stages otherwise a lot of shedding of flowers and bolls will take place which will ultimately result in depressed yields. Last irrigation should not be given after the opening of about 1/3rd bolls.

Topping in Desi Cotton

Where cotton has a tendency to make overgrowth, growing point of the green stem may be nipped off.

Use of Harmones

(a) **Naphthalene Acetic Acid (NAA) :** NAA should be sprayed twice. First spray of 25 cc per acre at flower appearance (2nd or 3rd week of August) and its second spray of 70 cc, 20 days after the first spray should be done. It helps in better boll formation. In no case, brackish or saline water should be used with it.

(b) **Cycocel Spray** : Where vegetative growth in case of American cotton is expected to be more than the normal growth, spray cycocel (50% ccc) @ 32 ml/ha dissolved in 350-400 litres of water at square formation stage of cotton. It can be mixed with insecticides and/or urea at the time of spraying.

Picking

Cotton should be picked clean and dry to get maximum price in the market. American cotton is ready for first picking in the month of October. The picking should be done at 15-20 days intervals. **Desi** cotton is ready for picking in the third week of September. Its pickings should be done at 8-10 days intervals to avoid ground losses. Store **kapas** in dry godowns and market on cooperative basis.

PLANT PROTECTION MEASURES

Insect Pests

The Jassid and bollworm (Pink and spotted bollworms) are the key insect pests of cotton occurring regularly in Haryana. However, during favourable weather conditions, *Helicoverpa* (American bollworm) also makes its apperance important and significant The other insects which damage the crop during certain years or in certain localities are hairy caterpillars, semilooper, leaf roller, surface grass hopper, eutworm, white fly, thrip, aphid, mite, dusky cotton bug, red cotton bug and the termite. These insects damage different parts of the plant during germination, vegetative and reproductive phase of the crop and cause quantitative and qualitative loss to the produce.

1. The termites attack the roots of the seedlings (May-June) as well as the mature plants (September). They cut and eat the roots and cause the plant mortality.

2. Cotton jassid, thrip and white fly suck the plant sap from the leaves. The affected leaves turn yellow, curl, dry and shed. The plant growth is retarded and yield reduced. Jassid causes maximum damage during July-August while thrip during May-June and the white fly during August-September.

3. Hairy caterpillars, semilooper, cotton leaf roller and grey weevil attack the foliage and cause damage during July-September, while the surface grass hoppers feed on the cotyledonary leaves. Hairy caterpillars (Red and Bihar) cause much damage to the cotton leaves during July and August in Sirsa Area.

4. **Cotton bollworms** : Spotted bollworm and pink bollworm attack the fruiting bodies (buds, flowers and bolls) during July-October. In the early stage of the crop the young larvae of spotted bollworms enter and damage the terminal shoots which

dry up. However, during reproductive phase the larvae of pink bollworm and spotted bollworms enter the young fruiting bodies and feed there in/on the developing seeds and the floral parts. Affected fruiting bodies either shed off or produce low yield of poor quality.

During the years of favourable weather (Intermittent rains during end August and early September, cloudy weather the temperature between 30-35°C) *Helicoverpa* attack on cotton becomes serious and causes significant loss in yield.

5. Nymphs and adults of red cotton bug and dusky cotton bug suck sap from the developing seeds and reduce the quality of seed, soil contents and the yield of seed cotton. And also these bugs get crushed alongwith cotton during ginning resulting in staining of cotton.

Integrated Management of Cotton Pests

1. All seeds meant for sowing should be fumigated to kill diapausing larvae of pink bollworm. Aluminium phosphide (Celphos/Phosfume/ Quickphos) should be used for fumigation @ one tablet (3g) per cubic meter of space with a fumigation period of 48-72 hours.

2. Grow early maturing varieties.

3. Complete sowing in the shortest possible period preferably in May. Never show the late maturing varieties after mid May.

4. Make balanced use of fertilizers as per the soil test. Use of nitrogenous fertilizers alone or the excessive use of nitrogenous fertilizers attract more of pests.

5. (a) In the termite prone fields mix 10-12 kg BHC 10% dust at the time of land preparation before sowing.

   (b) Treat the soaked cotton seed with chlorpyriphos, 20 EC @ 10 ml per kilo seed. For this take 10 ml chlorpyriphos, mix an equal volume of water (10 ml) and treat each kg of the soaked cotton seed with this 20 ml emulsion. Dry the treated seed in shade for 30-40 minutes and the seed is ready for sowing.

6. Hoeings and weedings should be done regularly so as to keep the field weed free and the soil loose.

7. Spotted bollworm infested drooping shoots and the pink bollworm infested rosetted flowers should be collected and destroyed twice a week so as to reduce their following incident on fruiting bodies (bud, flower, boll).

8. Collect and destroy the leaves and branches having egg masses or young larvae on them. The affected parts should be plucked/ cut and destroyed immediately.

9. Keep a strict vigil of pests on the crop. Survey/inspect the crop every week for the population of insect pests and the parasite/ predators, in the field. As soon as the insect population/damage reaches the economic threshold, recommended control measures should be adopted and the inspection/survey should be continued.

Note :

1. Do not use the same insecticide or insecticide of the same group repeatedly.

2. Repeat spraying if it rains within 24 hrs of spray.

3. In the termite prone fields, mix 10-12 kg BHC 10% dust before sowing at the time of land preparations and also treat the soaked seed with chlorpyriphos 20 EC @ 10 ml per kg seed. To do seed treatment take 10 ml chlorpyriphos 20 EC and add an equal quantity of water and treat one kg soaked seed with this emulsion. Dry the treated seed in shade for 30-40 minutes and sow.

4. If during May-June there is an attack of cut worms or surface grasshoppers on germinating/growing cotton then dust the crop with 10-12 kg BHC 10% dust or 6-8 kg fenvalerate 0.4 D per acre.

5. In case of *Helicoverpa armigera* (*Heliothis*/bollworm/American bollworm gram pod borer) attack at or above economic threshold (monitor regularly and target the young stage) spray the crop with 1-1.2 l quinalphos 25 EC or endosulfan 35 EC or chlorpyriphos 20 EC (Durmet/classic/lethal) or 1-1.2 kg carbaryl 50 WP or Sevin flo 42 A. F. or 1.1-1.3 l quinalphos 20 AF or 600-750 ml triazophos 300 g methomyl (Lanet) 40 S. P. in 200-250 l water per acre with fine turned nozzle. Do add 60-75 ml sticker in the spray material per acre. Pick out and kill the advance staged larvae in the kerosenized or insecticide mixed water.

6. For the control of hairy caterpillars, follow the recommendations made under Bajra crop.

7. Due to malformation in cotton the leaves, the growing shoots and the buds elongate. The affected fruiting bodies shed while the affected leaves thicken, the veins become more prominent and the leaves look like monkey paws. The reason for this malady is the effect of minute quantities of 2, 4-D on cotton which may reach the crop through the contaminated sprayer or the contaminated formulations. To protect the crop from this malady, test the insecticides on a few plants before commercial use, clean the spray pump and change the washer (boki) before use. In the affected fields, detop the affected shoots upto 15 cm and spray the crop with 2.5% urea + 0 5% zinc sulphate in 200-250 l water per acre.

8. 120-200 l spray material per acre recommended above refers to application through knap sack hand operated sprayer (medium volume sprayer). However, with high volume sprayers (Double barrel bucket pump, foot pump, rocking sprayer) the quantity of spray material required will be 250-400 l and with power operated knap sack sprayer cum mist blower 40-60 l spray material will be required per acre. High clearance, tractor operated sprayer may be used in the crop sown by seed drills/plants.

Off Season Operations

1. After the last picking, lot of insects in different stages remain hidden therein the cracks and crevices in the soil, amongest the fallen materials and in the opened, half opened and unopened (green) bolls and carryover to the next season. To do away with these insects, graze sheep, goats and other cattle in the cotton fields.

2. Do not take/keep a ratoon crop of cotton. Uproot and destory even the rare ratoon plants. Always uproot the cotton sticks or cut the sticks near the base and destory the stubbles.

3. Stack the cotton sticks in the villages and not in or around the cotton fields. All the opened/unopened/half opened bolls and the infested seed cotton attached to bolls plant after final picking should be removed and brunt so as to kill the diapausing larvae of pink bollworm.

4. Cotton fields should preferably be ploughed with a furrow turning plough by the end of February to expose the diapausing/hiding larvae or pupae so that the same are picked up by the birds or the other predators.

5. Always try to grow rabi crops in the cotton fields.

6. Alternate hosts of bollworms namely 'Kangi butti' and 'Peeli butti' growing on bunds, water channels and waste lands should be destroyed. Bhindi and holly hock should not be grown near cotton fields.

7. All the trash collected during ginning at the ginneries should be collected and burnt to kill the diapausing larvae of pink bollworm. All seeds from ginneries should be removed by the end of April. The seeds not meant for sowing should be despatched to the oil mills for extraction of oil. The uncrushed seed left in the mills should be fumigated latest by first week of May so that the diapausing larvae in the jointed or the single seeds are killed.

8. Use of cotton seed as cattle feed should be avoided, instead cotton seed cake should be used/preferred for the purpose.

9. Even the healthy seed cotton (Kapas) may harbour pink bollworm larvae. Hence, the Kapas retained should be ginned by the end of March.

10. Spotted bollworm infested twigs (droopings) should be collected and destroyed twice a week until the fruiting bodies become infested. The pink bollworm infested rosetted flowers and other fruiting bodies should be collected and destroyed twice a week.

Economic Threshold (ET) of major insect pests of cotton

Insect	Stage	Economic Threshold	Based on
1	2	3	4
Jassid	Nymph	i) Two jassid nymphs/leaf	30 leaves on 10 plants
		ii) 20% leaves start cufling or become yellow from margins.	
Whitefly	Adult	i) 6 adults per leaf	30 leaves on 10 plants
		ii) Plants look shining and sticky in the morning	

1	2	3	4
Termite	Dead plants	10% plant mortality	Count on plants in 30 one meter rows
Hairy caterpillar and other leaf eating insects	Larva	One larva per plant	30 plants
Spotted & Pink bollworms	Affected shoots & fruiting bodies	1% affected shoots	Observe on 30 plants
		ii) 5% affected fruiting bodies	Observe fruiting bodies on 20 plants
		iii) 5% affected bolls	Observe 100-150 bolls from inside
Pink boll worm	Adults	i) 5 adults per trap per night (June–mid Aug.)	Use pheromone trap of 60×60 m distance
		ii) 8 adults per trap per night–(mid Aug.–Oct.)	Average of 3 nights catch
		iii) 5% affected fruiting bodies	Observe all fruiting bodies of 20 plants
American bollworm	Larva	i) 0.5 larva per plant	10 larvae on 20 plants
	Fruiting bodies	ii) 5% affected fruiting bodies	All fruiting bodies of 20 plants

Note : As soon as the pest population reaches the economic threshold, the crop should be sprayed with any of the insecticides given in next table.

Diseases

Seedling Diseases : In the initial stages the crop suffers a great deal of losses due to mortality of young seedlings which is caused

by soil and seed borne organisms. These organisms usually attack the tender stem at the soil level and produce reddish brown lesions and consequently lead to collapse of the seedlings.

Myrothecium Leaf Spot : Spots on leaves, one or more circular or oval, light brown with reddish violet margin, impregnated with dot like fruiting bodies of the fungus in concentric rings. In severe cases, spots may coalesce and the affected lamina may fall off, causing shot holes. Similar symptoms also appear on bracts and less often on bolls.

Angular Leaf Spot or Bacterial Blight : This major disease of cotton is characterized by angular and water soaked lesions on leaves, turn dark brown having reddish or purple margins when old; lesions on stem are long, elliptical or irregular and dark coloured; spots on bolls are circular water soaked and later turn dark.

Anthracnose : Red spots appear on seedlings which girdle the stem and kill them; spots are somewhat sunken on bolls and slimy pink mass generally found on the affected bolls.

Root Rot : When temperature remains high, this disease is noticed in patches. The affected plants wilt suddenly, root rot and show shredding of bark.

Seed may be treated with carbendazim @ 2.5 g per kg seed. With the first appearance of root rot the affected plants may be removed and soil may be drenched with 0.2% of carbendazim.

Grey Mildew or Ramularia Blotch : Appear late in the season in *arboreum* cotton, when most of the seed cotton is already picked. The mildew spots are chiefly noticed on the older leaves as small, irregular white angular spots on the lower surface. Affected leaves fall-off prematurely.

Boll Rot Complex : A large number of fungi, bacteria and insects cause this damage by directly reducing the yield of seed cotton. Some organisms produce water soaked spots later turning dark with or without sunken centre. Bolls affected with boll worms injuries may be damaged by various fungi staining the lint dirty pale or black.

Leaf Curl of Cotton : First symptoms are noticed on young leaves which become thickened and the leaves appear more darker with upward turning of the leaves taking the shape of cup. On some of the affected leaves on the under surface a leaf like structure appear. Affected plants remain stunted and do not form flower and balls resulting in drastic reduction of yield. The disease is caused by a virus which is transmitted by white fly.

Chemical control schedule for cotton pests (Ground spray)

Time of spray	Probable pest attack	Approximate number of sprays	Insecticides recommended and their dose/acre	Spray material/ acre (Litres)	Remarks
1	2	3	4	5	6
End June to July	Thrip, Jassid	1-2	(A) 250-350 ml dimethoate (Rogor) 30 EC or 300-400 ml oxydemeton methyl (Metasystox) 25 EC or formothion (Anthio) 25 EC or 75-100 ml phosphamidon (Dimecron) 85 SL.	120-150	Spray the crop when 20% leaves turn yellow and curl or when on an average there are 2 or more jassid nymphs per leaf.
End July to Mid August	Spotted boll-worm, hairy caterpillars, semi-looper and other leaf eating insects	0-1	(B) 600-800 ml endosulfan (Thiodan/Hildan/Thiotox/ Endocel) 35 EC or 500-650 g carbaryl (Sevin/Hexavin/ Carbavin) 50 W. P. or Sevin flo 42% or 500-600 ml fenitrothion (Folithion/Sumithion/ Accothion) 50 EC or 600-700 ml quinalphos (Ekalux) 25 EC or 650-750 ml Ekalux 20 AF	150-175	Spray when jassids are not there in the field and the leaf eating insects and shoot damage reaches economic threshold. These recommendations hold good for **desi** cotton as well.

Note : If there is simultaneous attack of sap sucking & leaf/boll eating insects, take one insecticides from 'A' & one from 'B' group and spray on the crop or spray 400-500 ml monocrotophos 36 SL per acre.

1	2	3	4	5	6
Mid August to mid October	Spotted bollworms, Pink bollworm, American Bollworm, Semilooper		(C) 700-900 g Carbaryl 50 W. P. or Sevin flo 42% or 700-900 ml fenitrothion 50 EC or 500-650 ml monocrotophos 36 SL or 650-750 ml phosalone (Zolone) 35 EC or 800-1000 ml quinalphos 25 EC or 900-1100 ml quinalphos 20 AF or 500-600 ml triazophos (Hostathion) 40 EC or one kg Neem (Achook/Nimbicidin).	175-200	(i) Initiate spraying when either the bollworms infestation reaches the economic threshold or 25% plants start bearing flowers. Thereafter spraying may be repeated at 12-15 days interval or whenever the economic threshold is reached.
			(D) 80-100 ml cypermethrin (Cyperkill/cymbush/hilcyprin/cyperguard) 25 EC or 200-250 ml cypermethrin (Ripcord/Ciloord/Cyperguard) 10 EC or 100-125 ml fenvalerate (Fenval/Sumicidin/Agrofen/Milfen) 20 EC or 160-200 ml decamethrin (Decis) 2.8 EC or 100-125 ml alphamethrin (Alphaguard) 10 EC or 120-150 ml fluvalinate 25 EC.		(ii) Sparying with insecticides from group 'C' and 'D' should be done at alternate turns and the insecticides of group 'D' should not be used for more than two rounds during the crop season. (iii) These recommendations hold good for desi cotton also.

(iv) If during end August and early September there are intermittent rains and the temperature ranges between 30-35°C, then there are possibilities of *Helicoverpa* flare up. For the control of this pest, monitor it regularly and target the young stage and spray the crop with insecticide recommended at Sr. No. 5 under note.

Note : If during August-September there is simultaneous attack of jassid and bollworms at economic threshold then spray the crop by tank mixing 400 ml dimethoate 30 EC or 500 ml oxydemeton methyl 25 EC or 120 ml phosphamidon 85 SL with any one of the recommended insecticides from group 'C' or spray the crop with 650 ml monocrotophos 36 SL in 200 l water per acre.

For prevention of the disease cultivation of Desi cotton is recommended as it does not contract infection. Keep strict vigilance of the disease appearance destroy or burn the affected plant immediately. Have complete control of white fly through recommended insecticides and keep field free from all kind of weeds. Since okra is susceptible to this disease, do not grow okra crop around cotton.

Integrated Disease Control Measures

1. **Seed Treatment** : For eradication of seed-borne infection dip the seed in solution of fungicides (Emisan 1/2 gm and Agrimycin-100/ Streptocycline 100 mg in one litre water). 1 litre solution is sufficient 500-800 gm seed. This treatment controls both internal and external seed-borne infection. In areas where root rot is problem, seed treated above may be dressed with Bavistin 2.5 g/kg seed just before sowing.

2. **Spray Schedule** : Spray the crop with Agrimycin-100/ Plantomycin (30-40 g/acre) or Streptocycline 6-8 g/acre alternating with copper oxychloride (600-800 g/acre) from last week of June or beginning of July or when the crop is six weeks old at 15 days interval about 6 times carbaryl may be mixed with copper oxychloride to check boll rot.

For better retention of fungicides on plant surface mix 10 gm Sel-wett 99 or 50 ml/Triton per 100 litres of fungicidal solution.

In *arboreum* cotton, sulphur dust @ 10 kg/acre mixed with 5% DDT (3 : 1) Bavistin (2 g/litre of water) may be used for control of grey mildew.

3. **Other Measures**

(i) Don't grow cotton for three years in those areas where root rot has been serious in previous year.

(ii) Root-rot can be controlled by sowing moth in alternate rows with cotton.

(iii) Destroy the plant debris after harvesting the crop and gives one deep ploughing. For fast decomposition of infected plant debris, irrigate the field after ploughing. Destroy self grown plants as and when noticed in the field.

Tirak is physiological disorder, characterised by bad opening of bolls and appears sometimes in the western parts of Haryana. The deficiency of nitrogen in sandy soil results in reddening of leaves and suppression of growth. Spell of high temperature during flowering and fruiting

phases of plant growth are the major causes of this malady. Adequate fertilization and timely irrigation to avoid water stress during flowering and fruiting stages and to keep the soil temperature down are highly essential to obtain good yield of recommended varieties.

HINTS FOR MAXIMISING COTTON YIELD

(i) Sow improved varieties suited to different agro-climatic conditions.

(ii) Sow at the right time.

(iii) Treat the seed before sowing.

(iv) Use acid delinted seed for good germination.

(v) Sow the seed at proper depth spacing and in optimum soil moisture with a seed drill/planter to ensure good germination.

(vi) Make use of recommended doses of fertilizers.

(vii) Control different pests by adopting spray schedule.

SUGARCANE

Sugarcane occupies about 1.50 lakh ha area in Haryana. The average cane yield of the crop is 535 quintals per hectare which is almost half the yield obtained in South India. This yield difference is mainly because of relatively poor growth conditions in northern part of the country as far as sugarcane is concerned. However, in some of the crop competition plots, yield as high as 1800 quintals per ha has been recorded.

The area and production under this crop in Haryana during the last decade is as under :

	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95
Area (000' ha)	106	124	142	131	126	147	161	134	112	122
Production cane (000' ton)	5.150	6740	5240	6580	6750	7750	9000	6550	6420	7010
Average yield cane (kg/ha)	486	544	369	502	536	527	559	489	576	584
Sugar recovery (%)	9.48	9.91	9.94	9.83	9.77	9.91	9.73	10.0	9.52	9.19

By adopting the following recommended practices, marked improvement in the overall yield of sugarcane can be achieved.

VARIETIES RECOMMENDED

Early Maturing

Co. 7717 : It is an early maturing variety which ripens by the end of November. Sucrose content is about 17%. A good tillering early maturing variety, with excellent stand, good ratooner, erect growing and non-lodging responds well to heavy manuring, resistant to drought, cane yield and sugar content fairly high. It gives about 320 quintals of stripped cane per acre. It is moderately resistant to smut, but susceptible to red rot. Suitable for whole of Haryana.

CoJ-64 : An early maturing high sugared variety, excellent germination, ratoon fairly good, sensitive to droght and responsive to fertilizer. surceptible to top borer, red rot and root borer, moderately resistant to smut and grassy shoot disease. Recommended for Ambala, Kurukshetra and Karnal and part of the state with irrigation condition. Average yield 220 q/acre.

CoH 56 (Haryana 56) : It is early maturing and high sugared and lodging resistant variety. It has good ratooning capacity. Av. yield is 300 qtl. and contains 9.5 to 14% sugar. Susceptible for Red Rot and ghasela diseases.

Mid Season

CoS 767 : Good germinator with solid cane, non-lodging habit, excellent ratooner, resistant to drought, frost, red rot and tolerant to borer. Average yield 310 q/acre.

Late Maturing

Co. 1148 : A late ripening variety with medium thick canes, compact growth. Its average cane yield is 340 quintals per acre. Frost resistant. Early sowing in the season and soil application of recommended insecticides are a must as this variety is susceptible to shoot borer and root rot. It can contain sucrose content upto May.

CoH 35 (Haryana 35) : It is very quick growing variety of sugarcane and recommended for planting after wheat harvest. The cane

is very tall, thick, solid and soft but lodging susceptible. It matures in 1st week of January and gives 18-20 per cent sucrose with 320 quintal cane yield per acre. The paired row planting, proper earthing up and propping are essential for this variety. The variety is recommended for entire western zone of the state with half dose of recommended nitrogenous fertilizer and late planting conditions.

AGRONOMIC PRACTICES

Selection of Seed

Use 2/3 top portion of healthy, vigorous, disease and pest free cane.

Seed Rate

35,000 two-bubbed setts or 24,000 three-bubbed setts which weigh about 30 to 40 q/acre. For variety CoH 35 40-50 q/acre should be used.

Seed Treatment

Dip the cane setts in 0.5% of MEMC with 3% mercury (Agallol) or 0.25% MEMC with 6% mercury (Emisan) or 0.25% mancozeb (Indofil M-45 or Manzeb) before planting. 100 litres of solution is sufficient for treating setts to be planted in one acre. Rubber gloves should be put on while treating the seeds. The person employed for should not have any cuts or scratches on his hand.

Sowing Time

The best time of planting is from 15th Feb. to end of March for spring crop and end-Sept. to first week of Oct. for autumn crop. Sow CoH-35 from April to 15th May after harvesting of wheat crop. Heavy suhaga should be used after planting to conserve moisture. Remove weeds, create dust or trash mulch after rains to preserve moisture for autumn planting. Avoid planting in mid day.

Planting

Flat planting in rows of 60 to 75 cm apart. In case of intercropping with potato-sugarcane crop, plant to plant distance should be kept 90 cm. Variety CoH 35 must be planted at 45 cm spacing.

Fertilizer Recommendations (kg/acre)

Regions	Nutrients*		Fertilizer		Time and method of application
	N	P_2O_5	CAN/ Urea	Super-phos-phate (16%)	
1	2	3	4	5	6
Plant crop	60	20	240/135	125	Drill all P and 1/3 N at sowing, 1/3 with second irrigation and 1/3 with fourth irrigation.
Ratoon crop					
Entire State	90	20	360/200	125	Drill 1/3 N & full P_2O_5 in Feb. with first interculture, apply 1/3 N in April and the rest in June.
Autumn planting	60	20	240/135	—	For the inter-crop apply the recommended dose of fertilizer. For sugarcane crop, apply 20 kg N/acre at planting time, 20 kg N/ acre after harvesting the inter-crop and the final dose in the second fort-night of June.

*Fertilizers applied on the basis of soils test give a better yield.

In case of plant crop one third nitrogen dose and full phosphorus and potash should be applied at planting. If the soil moisture is insufficient at planting time half nitrogen dose may be applied in May in irrigated areas with the remaining half nitrogen dose in June. Phosphorus in ratoon crop should be applied only when soil is low & medium in available phosphorus. Under rainfed conditions, the entire nitrogen is to be applied at the onset of monsoon. Apply 10 kg zinc sulphate per acre if sugarcane is being planted in light textured soil.

Interculture

Blind hoeing followed by **sohaga** may be given 7-10 days after planting and 2-3 hoeings depending on weed infestation should be given later.

Factors favouring weed growth are : (i) warm and humid climatic requirements of sugarcane, (ii) slow germination and initial slow growth of crop, (iii) wide spacing in the crop rows provides adequate space and light for weed growth, and (iv) crop requires heavier manuring and more irrigation, thus favouring weed growth.

Weed Control

Effective method of weed control is to spray 1.6 kg of Simazine (50 WP) per acre in 250-300 l of water, 2-3 days after planting. Nutgrass and **doob** may sometimes infest the crop and hand-hoeing or bullock drawn cultivar weeding may be required after irrigation when the crop is well established. 2, 4-D may be applied in two-split sprayings. The first dose of 2, 4-D (sodium salt 80%) @ 1 kg per acre in 250 l of water can be sprayed three weeks after planting the crop and second similar dose, two weeks after earthing up the crop. Thus, the broad leaf weeds and grass weeds can be effectively controlled by cultural-cum-chemical methods of weeding.

If **doob** and **baru** are the major weeds, give spot treatment of Dalapon at the rate of 0.5% solution concentration three times at an interval of 15 to 20 days. First spraying should be done around 45 days after planting or when **doob** has spread in the field. Take care that spray does not fall on sugarcane plant.

If nutgrass is a problem, then spray 2, 4-D ester @ 400 g a.i./acre when nutgrass has emerged. A second spray of the same concentration may be necessary if nutgrass emerges again, 2, 4-D kills only top portion of nutgrass.

Irrigation

Give first irrigation after six weeks of sowing. Irrigate at 10 day intervals during pre-monsoon and at 25 day intervals during post-monsoon period. In **barani** areas, trash mulch may be resorted to for conserving moisture. The trash used must be from healthy crop. Variety CoJ 64 requires assured and frequent irrigations. Co 1148 and CoS 767 are drought tolerant. Trash mulch may be resorted to for conserving moisture. The trash used must be from healthy crop.

Earthing

Light earthing in May and heavy earthing in the end of June, prior to the break of monsoon, should be done.

Propping Up

This should be carried out in August and September, so as to prevent lodging of crop.

Ratoon Management

(i) Crop should be harvested at ground level or if harvested above ground level, stubble shaving should be done within 15 days of harvest.

(ii) Trash burning or trash removal after crop harvest.

(iii) Adequate irrigation during pre-monsoon period.

(iv) Application of nitrogen at 90 kg N/acre in instalments as given through fertilizer recommendations.

(v) Intercultivation to loosen the soil and to control weeds.

(vi) Gap filling.

(vii) Control of pest and diseases as and when required.

PLANT PROTECTION MEASURES

Insect Pests

Sugarcane crop is attacked by many insects. At the germination stage many buds are destroyed by termites and the infested young plants may dry up completely. Plants attacked by shoot borer show characteristic dead hearts. Presence of holes on the leaves, streaks in the leaf mid-rib and dried up central leaf in the whorl reveal the attack of top borer. From July onwards canes attacked by this borer also have bunchy tops. The Gurdaspur borer is serious from end of June to Sept. when whole tops of infested canes dry up and break when slightly jerked. Tarai borer, another very serious best is present in all sugarcane tracts of Haryana. It is most serious from September till harvest and may bore through the whole length of the cane. Root borer is more serious from Sept. to November.

Among the sucking pests infesting sugarcane, black bug and mite are serious from April to June and pyrilla in April-June and August-November and white-fly from August to October mostly in ratoon crop of humid areas. They lower the vitality of the plants by sucking sap from the leaves.

For controlling sugarcane pests, follow the following integrated approach :

Period	Pest	Control measures
1	2	3
Feb.-March (Sowing time)	Termites and shoot borer	Mix 2.5 litres chlorpyriphos (Durmet/ Lethal/Dursban/Classic/Rodar) 20 EC or 1.5 l endosulphan (Endocel/Thiodan/ Agro-endosulphan) 35 EC in 600-1000 litres of water per acre and apply in furrows over the cane setts with sprinkling cans. Furrows should be covered immediately after treatment. In case if it is not possible to apply Gamma BHC and chlorpyriphos apply BHC 10% dust @ 20 kg/acre.
April-June	–do–	In case of ratoon crop, rake into the soil 10% BHC dust @ 10-15 kg/ acre.
May-October	Top borer	Collect and destroy the egg masses, moths and infested shoots. Apply carbofuran (Furaden) 3 G @ 13 kg/ acre or phorate 10 G @ 8 kg/acre with last application of fertilizer during end June or first week of July and give a light irrigation. Do not apply carbofuran or phorate in areas where incidence of top borer remains less than 15 per cent. However, application of carbofuran of phorate is very necessary in all such areas where ratoon crops during May have around 5 per cent or more incidence of top borer.
April-June	Black-bug	Spray endosulfan (Thiodan/Thiotox/Endocel) 35 EC @ 550 ml or fenitrothion (Folithion/ Sumithion) 50 EC @ 400 ml or phenthoate (Elsan/Phendal) 50 EC @ 400 ml or dichlorvos 76 EC @ 160 ml/acre in 400 litres water per acre with manually operated sprayer. While spraying, the nozzle of the sprayer should be directed towards the central whorl where nymphs and adults hide during day time. It is better to spray the crop with foot or rocking sprayer. Spraying should be repeated

1	2	3
		after 25-30 days if pest reappears in serious form.
April-Nov.	Pyrilla	The pyrilla is effectively controlled by its egg and nymphal adult parasites. Three species of egg parasites viz. *Tetrastichus pyrillae* Crawf., *Ooencyrtus popilionis* and *Cheiloneurus pyrillae*, two species of nymphal parasites viz. *Drynus pyrillae* and *Chlorodrynus pyrillae* and one species of nymphal adult parasites viz. *Epiricanea (Epipyrops) melanoleuca* are commonly found in this state, but most effective among them are egg and nymphal-adult parasite. Among the egg parasites, *O. papilionis* is more effective during April-October, *I. pyrillae* from August-November and *C. pyrillae* during October-January when eggs are laid in leaf sheaths. These parasites are mass multiplied at the HAU Regional Research Station, Uchani, Karnal and are supplied to Cane Development staff of Haryana Govt. and sugar factories of Haryana for their release in the pyrilla infested sugarcane fields. Parasitised eggs of pyrilla become brown, black or pink in colour while the nymphs attacked by *Drynus & Chlorodrynus* bear raised black spot on the abdomen due to the attachment of parasites' larvae. In case of *Epiricanea*, the larvae attach themselves on the body of pyrilla nymphs and adults and they can be seen as a raised white spot on the abdomen of nymphs and adults. In case of adult pyrilla, the wings get slightly raised due to the attachment of larvae on the abdomen below the wings.
		An egg parasite is able to parasitize about 20-25 pyrilla eggs in its life time and becomes about 1000 pairs by a pair of adults in a month time. Almost all the egg parasites complete their one life cycle in about 10 days. The nymphal-adult

1	2	3
		parasite *(Epiricanea)* takes about 30-40 days to complete one generation and a female of this parasite lays 500 to 1200 eggs in its life span of 2-3 days. The incubation, larvae and pupal durations of *Epiricanea* is 5-7 days, 15-25 days and 5-8 days, respectively. Though the parasites are present in nature throughout the year, yet the conditions prevailing in nature from July to Oct./Nov. are more favourable for their multiplication than in the remaining parts of the year. In case, pyrilla assumes epidemic form and its parasites are not available in the fields, use of following insecticides is resorted. Spray malathion (Cythion/Malamar/Maltaf/Malathion) 50 EC @ 400-600 ml or endosulfan 35 EC (Thiodan/Thiotox/Endocel) @ 400-600 ml or fenitrothion 50 EC @ 400-600 ml in 400 to 600 litres water per acre (depending upon the growth of crop). Dusting of BHC 10% @ 10-15 kg/acre also provides effective control.
April-June	Red mite	Spray methyl-demeton (Metasystox) 25 EC @ 500 ml or dimethoate (Rogor) 30 EC @ 600 ml in 250 litres water per acre with manually operated sprayer on the appearance of mite in the sugarcane fields.
June-Sept.	Gurdaspur borer	1. Collect and destroy the infested shoots at weekly intervals regularly from end of June to end of September. 2. The stubbles of crop not meant for ratoon should be destroyed.
August	Root borer	Generally infest sugarcane in the initial stages of crop growth, though the attack remains very low during pre-monsoon period. However, the population reaches the peak during Sept.-Nov. Any insecticide applied for shoot borer will also

1	2	3
		control the root borer in pre-monsoon period. During post-monsoon period apply 8 kg quinalphos 5 g per acre once in the end of August.
August-Nov.	White fly	Wherever, whitefly appears in serious form, spray malathion (Cythion/Malamar/ Maltaf/Malathion) 50 EC @ 800 ml or dimethoate (Rogor) 30 EC @ 640 ml/acre or methyl demeton (Metasystox) 25 EC @ 800 ml/acre in 400 l of water with manually operated sprayers. If pest appears in August or early September, spray any of the above 3 insecticides but if it appears in late September or October, spray only malathion to avoid residual effect of dimethoate or metasystox on human being and cattle. If pest appears in large areas in August and September, aerial spraying with systemic insecticides may be preferred.
August-March	Tarai-borer	After harvesting, left out canes should be destroyed. Do not grow susceptible varieties and avoid lodging of crop by tying of canes and earthing up.

SCALE INSECTS

The incidence of scale insect is presently confined to Sonepat and Faridabad districts only. If not checked, it is likely to spread to other sugarcane growing areas. The scale insects infest the lower portion of the cane more particularly. The juice quality and the sugarcane recovery from the attacked canes is affected adversely. The following management practices are recommended for its control :

1. The scale infested areas may be covered under pest act and no movement of seed cane may be permitted under any circumstances from these areas to adjoining cane areas.

2. The mature cane for crushing, either at the sugar mill or in Khandsari or Gur units, may also be totally prevented from diversion to the outside areas covered under pest act. Check posts may be established and rigorous action enforced for prevention of the cane movements outside.

3. For planting within the area, either healthy seed may be planted or seed material soaked with 0.1% malathion (2 ml malathion 50 EC in 1 litre water) for 20 minutes may be used or hot water treated seed material from factory may be distributed to check the primary inoculum.

4. Only one ratoon may be permitted in the epidemic areas.

5. Leaf over dry trash along with the water shoots may be burnt in **situ** in the fields **immediately** after harvest.

6. Detrashing may be done two or three times, at the commencement of scale infestation and at sixth and eighth month of the crop age (followed by 0.1% malathion spray wherever possible).

7. Scale affected sugarcane may be harvested first in one lot, if possible.

8. Surveillance scheme may be put into operation to find the initial infestation, to watch the build up, to give instructions for carrying out the control operations and to have observations after treatment.

9. Drainage may be done thoroughly in low-lying areas subject to scale infestation.

10. In infested areas grow variety Co. 7314, which is moderately resistant.

Note : *During April-May, cutworms, crickets and grass hoppers can be controlled by dusting BHC 10% @ 10 to 12 kg/acre.

*Spray material of each schedule is on the basis of manually operated high volume sprayers. With power mist blower and mini-micron-77 power sprayer use 60-100 litres and 12-16 litres/ha, respectively.

Diseases

(a) **Red Rot** *(Colletortchum falcatum)*: Leaves wither canes shrink, showing dark specks on shrivelled rind; split cane gives alcoholic smell and shows red tissue with white cross bands. This can be controlled by the following measures :

1. Practise rigorous selection of healthy canes at the time of planting. Setts showing even the slightest discolouration at the cut ends should be ruthlessly discarded. Seed for planting should not be taken from red rot affected crop field.

2. Rogue out diseased canes and burn them. Remember to uproot the entire clump and not merely the individual affected stalk.

3. Arrange early crushing of crop from the affected fields. Plough up the disease affected fields as soon as possible after harvest. Collect the stubbles and burn them.

4. Abandon ratooning of diseased crop and follow at least one year's rotation in diseased fields.

5. Give preference to resistant variety like CoS 767 for planting in red rot affected localities.

(b) Wilt *(Cephalosporium sacchari and Fusarium moniliforme)*: Leaves dry up, stem becomes light and yellow, pith develops purple or red streaks.

Adopt the following practices to minimize losses :

(i) Select healthy setts for planting.

(ii) Follow at least three-year rotation in affected field.

(c) Smut *(Ustigo scitaminea)* : Growing shoots turn into long whip like black growth covered by black powdery spores enclosed in thin membrane. Sugarcane smut is controlled by the following measures :

(i) Remove the smutted whips generally without shaking, inside a closely woven drill bag. Then uproot the entire clump containing the smutted shoots.

(ii) Immerse the bag containing smutted whips in boiling water for 15 minutes after every roguing.

(iii) Use absolutely healthy seed from nursery where moist air treatment in given.

(d) Ratoon Stunting *(Coryneform bacterium)* **and Grassy Shoot Diseases** *(Mycoplasma)* : Diseased plants are stunted while in the latter, crop gives grassy appearance.

(i) Use seed setts selected from healthy crop.

(ii) Rogue out plants affected by grassy shoot to check further spread.

(iii) Moist air treatment of the cane seed at 54°C for four hours is very effective for inactivating the causal organisms of the diseases (For seed nurseries). Farmers should procure seed from such nurseries.

HINTS FOR MAXIMISING CANE YIELD

(i) Sow improved varieties of sugarcane suitable for different areas.

(ii) Use healthy seed free from pests and diseases; treat setts with mercurial fungicides at planting.

(iii) Use proper seed rate and spacing.

(iv) Sow at the right time; avoid late sowing.

(v) Earthing should be done with ridgers.

(vi) Manure adequately with nitrogenous fertilizers, apply them at the right time.

(vii) Irrigate frequently during summer.

(viii) Control pests and diseases at the right time.

GUAR

For Seed

Guar is an important **kharif** crop of dryland areas of Haryana. **Guar** for seed is mainly grown in the districts of Bhiwani, Hisar, Mohindergarh, Gurgaon, parts of Sirsa, Rohtak and Jind. It has assumed a great industrial importance in recent years mainly due to the presence of gum in its endosperm, which constitutes about 30-35 per cent of the whole seed. **Guar** meal, the by-product is also of considerable values as it contains more than 42 per cent protein as against 31 per cent in guar seed. **Guar** gum has several diversified uses in textile, food processing, cosmetics mining, explosives and oil industries. Area and production under this crop in Haryana during the last decade is as under :

	78–79	79–80	80–81	81–82	82–83	83–84	84–85	85–86	86–87	87–88
Area ('000 ha)	203	179	250	299	297	327	313	274	247	121
Production ('000 ton)	186	124	143	187	193	208	192	162	154	85
Average yield (kg/ha)	919	694	507	624	648	637	613	591	623	702

Guar production can be further increased by use of improved varieties and better crop management practices.

IMPROVED VARIETIES

FS 277 : Its plants are erect-growing and without branches. It has thick, broad and dark green leaves. It gives seed yield of 5.6-6 q/acre.

HG 75 : It is a branched, high yielding, disease tolerant variety having high in gum content. It is bushy, short statured, synchronous in maturity even under late sown conditions It matures in 110-115 days. Seed colour of HG 75 is attractive and creamish white. This variety having high branching habit particularly under poor plant population and thus more suitable for dry land conditions. On an average, it yields 7-8 q/acre and 2-2.5 q/acre of gum can be obtained from its grain.

HG 182 : It is high yielding, tolerant to drought and diseases like bacterial blight and Alternaria leaf spot. It is branched and leaves are pubescent with relatively little serrated margin. Its seed is medium bold, round and grey in colour. On an average it yields 7-8 q/acre of seed and is better in guar gum productivity.

HG 258 : It was released for cultivation for whole of country for seed purpose during the year 1988 by the Central Seed Committee. This variety is 110-115 cm tall, branched with pubescent leaves and smooth leaf margin. It matures in 110-115 days and its seed is whitish and round in shape. Its average seed yield is 7.5-8.5 q/acre. It is better in protein and gum content and resistant to bacterial blight and Alternaria leaf spot diseases.

AGRONOMIC PRACTICES

Soil and its Preparation

Guar is grown on well drained medium to light soils. It cannot withstand stagnation of water. Well prepared seed beds are required for getting high seed yield. The first ploughing may be given with soil turning plough and subsequent one or two ploughings should be done with plough.

Sowing Time

Guar for seed production should be grown by middle of July. The early sown crop makes luxuriant growth and affects the yield. Seed yield is also reduced considerably when sown after third week of July.

Seed Treatment with Rhizobium Culture

Like other pulse crops, **guar** seed should also be inoculated with **Rhizobium** culture. Improved **Rhizobium** culture of **guar** is available from

the Department of Microbiology, CCS H.A.U., Hisar. The culture should be properly used according to the instruction supplied with the culture.

Seed Rate and Method of Sowing

A seed rate of 7-8 kg/acre is enough. The seed should be sown by **kera** under irrigated conditions and by **pora** in dry farming areas. Unbranched variety like FS 277 should be sown at 30 cm rows spacing whereas in case of branched varieties like HG 75 and HG 182 the crop should be sown at 45 cm apart. Plant to plant spacing of 15 cm should be maintained.

Fertilizers

16 kg P_2O_5 (100 kg single super phosphate) and 8 kg nitrogen (32 kg CAN 25%) per acre should be applied at sowing time.

Interculture

One hoeing after 25-30 days after sowing with hand wheel hoe should be carried out to check the growth of weeds, if needed one more hoeing can be done. For control of weeds in light textured soils, Basaline @ 400 ml a. i./acre (pre-planting soil incorporation) in 250 l of water can be used if manual labour is scarce or not available. The dose of Basaline should be increased by 25% for medium textured soils.

Irrigation

July sown crop generally does not require any irrigation. One irrigation may be given at the time of pod formation especially in case of complete failure of rains.

Harvesting and Threshing

The crop is to be harvested when the leaves turn yellow and fall down and the pods become straw coloured. Harvest the crop immediately after maturity to avoid any loss by shattering of seeds.

PLANT PROTECTION MEASURES

Jassids sometimes attack this crop. It may be controlled by spray of 200 ml of malathion 50 EC in 200 litres of water per acre with a manually operated sprayer. If crop is grown for fodder then fodder should be fed to the cattle after 7 days of spraying.

HINTS FOR MAXIMISING YIELD

(i) Prepare seed bed thoroughly and use recommended dose of fertilizer.

(ii) Use improved varieties.

(iii) Sow the crop in middle of July.

(iv) Treat the seed with **Rhizobium** culture before sowing.

(v) Use insecticide for controlling insect pests if needed.

(vi) Harvest the crop timely to avoid shattering of seeds.

OILSEED CROPS

GROUNDNUT

Groundnut is grown on an area of about 11 thousand hectares in Haryana. Average yield of groundnut in India is 308 kg/ acre against 340 kg/acre in Haryana. Selection of suitable high yielding varieties according to the soil type coupled with improved cultural practices and plant protection measures would certainly help in attaining high production level in this crop.

RECOMMENDED VARIETIES

MH-1 (Moongphali Haryana No. 1) : It is bunch variety and is recommended for sandy-loam and loam soil, where irrigation facilities are available and where growing of semi-spreading varieties is not economical. On an average it yields 8 q pods per acre. It has 70 per cent shelling out-turn, 100 kernels weight 50 g and oil content 51%. It matures in about 120 days.

MH-2 (Moongphali Haryana No. 2) : It is a bunch variety with very dwarf plants having dark green foliage. This variety is recommended for all types of soil and performs very well under irrigated conditions. It is resistant to 'tikka' disease and on an average, yields about 16 q pods per acre. Shelling percentage is 72 and 100 kernel weight is 34 g. The seed contains 50% oil. It matures in about 110 days.

MH-4 (Moongphali Haryana No. 4) : A semi-dwarf bunch type groundnut variety is recommended for irrigated conditions. It matures in 115 days and is resistant to tikka disease. On an average, it gives 14.4 q pod yield/acre at 30×15 cm spacing. Foliage is light green. Pods are thick and contain 2-3 kernels of small size (32 g/100 kernels) which possess 50% oil. Shelling percentage is 70.

M-145 : It is a spreading variety and is recommended for cultivation in sandy soils under irrigated conditions. It may require 4-5 irrigations in low rainfall areas and 2-3 irrigations in areas with medium rainfall. On an average it yields about 9 q pods per acre. It has a shelling out-turn of 76 per cent, 100-kernel weight 50 g, kernel contains 50.5 per cent oil. It matures in about 125 days.

M-13 : It is a spreading variety and is recommended for sandy or sandy loam areas with a rainfall of 50 to 100 cm having satisfactory arrangement for irrigation. It yields about 33 per cent more than M-145. It has a shelling out-turn of 68 per cent, 100 kernel weight 78 g, oil content 49 per cent. It matures in 145 days.

Punjab Groundnut No. 1 : It is a spreading variety and is recommended for sandy soils under rainfed conditions in all the groundnut growing areas with a seasonal rainfall of 50 to 100 cm. It can also be grown with irrigations provided the soil is sandy On an average it yields about 7.5 q pods per acre. It has a shelling out-turn of 69 per cent, 100 kernel weight 60 g, oil content 49 per cent. It matures in about 130 days.

AGRONOMIC PRACTICES

Rotation

A groundnut-wheat rotation can be taken successfully where irrigation facilities exist.

Soil and Climate

A well-drained sandy soil overlapping a loamy subsoil is considered ideal for the rainfed crop. Where irrigation facilities are available, sandy-loam and loam soils can also be used with advantage. A well-distributed rainfall of at least 50 cm during the months of July, August and September is essential for the rainfed crop.

Preparatory Tillage

The land should be prepared by giving two ploughings after the previous crop is removed. The third ploughing, if required, may be given at the end of June or early July. Very deep ploughing is not necessary except in land heavily infested with **kahi** or **dub**.

Sowing Time

The rainfed crop should be sown with the advent of monsoon which breaks in the last week of June to Ist week of July. The irrigated crop should be sown in the 4th week of June. Sowing done beyond July 15 usually yields low and the maturity is delayed.

Seed Rate and Method of Sowing

Healthy and well developed pods should be hand-shelled about a fortnight before sowing and selected disease-free kernels be given treatment with thiram or captan (1 : 300) or Ceresan (1 : 400).

The seed should be sown by '**kera**', '**pora**' or drill at a depth of about 5 cm. Spacings of 30×22.5 cm for variety Punjab Groundnut No. 1, 30×15 cm for varieties M-13, MH-1, MH-4 and M-145 and 15×15 cm for variety MH-2, are recommended. The seed with the above spacings works out to be 34 kg of well developed kernel per acre for Punjab Groundnut No. 1, 40 kg for MH-1, 45 kg for M-145, 60 kg for M-13 and MH-2 and 32 kg for MH-4. Where irrigation facilities are available, the field should be divided into a number of plots of suitable size, by raising bunds immediately after sowing, for giving protective irrigation if needed.

Fertilizers

Nutrients (kg/acre)			Fertilizers (kg/acre)			
N	P_2O_5	K_2O	Ammo. Sulph. (20%)	Super-phosphate (16%)	Muriate of Potash (60%)	Zinc Sulphate (21%)
6	20	10	30	125	16	10

Drill all fertilizers at sowing. Prefer N through Ammoniumsulphate and P through Superphosphate. Use 10 kg Zinc sulphate per acre by broadcasting at the time of sowing. Use of gypsum in groundnut was found to be useful.

Interculture

One hoeing including weeding three weeks after sowing and second weeding six weeks after sowing are important.

Irrigation

Two or three irrigations are required in areas with a seasonal rainfall of 50 to 70 cm. The first irrigation should be given at the start of flowering and subsequent irrigations may be given whenever required to keep the soil moist during the fruiting period which lasts from 1½ to 3 months after sowing for easy needle penetration. However, in low rainfall areas like Hisar, 3 to 4 irrigations will be required to raise a good

crop. If, however, water is very much limited and is available only for a single irrigation, the maximum advantage would accrue from its application during flowering. When two irrigations are possible, the first at the commencement of flowering and the second during fruit formation are recommended. The latter irrigation will facilitate penetration of needles.

The last irrigation given about a week before the harvesting of the crop, will help in full recovery of the pods and also be useful in sowing the succeeding crop.

Harvesting and Threshing

The crop is normally ready for harvesting towards the beginning of November. A reliable indication of maturity is the uniform yellowing of leaves as well as shedding of older leaves. When symptoms are not seen very clearly on the crop, harvesting may be done after 125-130 days of its sowing depending upon the variety. Use of tractor-mounted groundnut diggershaker is recommended to expedite harvesting. For the operation of this harvester, the soil should be in droper moisture condition, and the crop at harvesting should not be over-ripe.

PLANT PROTECTION MEASURES

Insect Pests

Hairy Caterpillars : Control measures are the same as under maize & Bajra.

Termite : Termites cause serious damage at many places. For seed treatment, see insecticides under white grubs.

White-grubs : These are serious in some of the localised areas. The beetles emerge during June-July with the first and second shower of monsoon rain. They congragate on nearby trees and feed on leaves. They should be killed by spraying the trees with 0.04% monocrotophos 36 SL or 0.05% quinolphos 25 EC or 0.15% carbaryl 50 W. P. on the same day or a day after each shower. Collection of adult beetles by shaking the trees on 1st and 2nd night after rain and killing them in kerosenised water is also very effective method if carried out on campaign basis. To protect the crop from grub attack, treat one kg seed with 15 ml chlorpyriphos 20 EC or quinalphos 25 EC before sowing.

Aphid : They suck plant sap and devitalize the plant. Its incidence is more during post monsoon period. If can be controlled by spraying 200 ml malathion 50 EC in 200 litres of water per acre.

Diseases

Collar Rot and Seed Rot : These diseases are caused by *Aspergillus niger* and other seed and soil-borne fungi.

Control

(i) Select healthy and unblemished seed.

(ii) Treat the seed before sowing with Emisan 2 g/kg seed and thiram or captan at the rate of (1 : 300).

Tikka or Cercospora Leaf Spot : Spot on leaves irregular to circular which turn brown to dark brown with age. It leads to defoliation and early maturity.

Control

Spray the crop with Indofil M-45 (0.2%) @ 600-800 g/acre or Bavistin @ 250 g/acre at 10 to 15 days intervals, starting from the period tikka spots first begin to appear in the first week of August.

HINTS FOR MAXIMISING GROUNDNUT YIELD

1. Sow seeds of M-145 and M-13 in sandy soil and that of MH-1 and MH-2 in sandy-loam soils.
2. Use healthy, disease-free and treated seed for better germination.
3. Follow the recommended spacings and seed-rate.
4. Use the recommended dose of fertilizers. Avoid excessive vegetative growth which results in poor yield.
5. Apply protective irrigations, particularly during flowering and fruiting period if rain fails.
6. Apply the recommended plant protection measures at appropriate time.
7. Follow timely weed control.

SESAMUM (TIL)

Sesamum is grown on an area of about two thousand hectares in Haryana. It is mostly grown as rainfed in high rainfall areas and hence

its yield mainly depends upon seasonal variations. The average yield of sesamum in Haryana is 140 kg/acre against 60 kg per acre in India. The following intensive cultivation methods may be adopted for enhancing the sesamum yield.

IMPROVED VARIETY

Haryana Til No. 1 : It is resistant to leaf curl and Phyllody the major diseases of the region. On an average, it yields about 2.9 q/acre giving about 24 per cent more yield than the old variety. It has medium height, dark green leaves, bold white seeds having 49 per cent oil. It matures in about 77 days.

AGRONOMIC PRACTICES

Soil and its Preparation

Sesamum thrives best on well-drained sandy loam soils. The land should be prepared by giving two or three ploughings followed by plankings.

Sowing Time

Sesamum is mostly sown as rainfed crop in the 1st week of July or with the advent of monsoon. As pure irrigated crop, the sowing should be done in the second fortnight of July.

Seed Rate and Method of Sowing

For securing better yields the crop should be sown by **pora** or drill at a depth of 4 to 5 cm. A spacing of 30×15 cm is recommended. Two kg of seed is enough for sowing one acre.

Manuring

Generally, no manuring is done. However, 10 tons per acre FYM before sowing will prove beneficial. In light soils of poor fertility drill 15 kg N (60 kg CAN 25%) per acre before sowing. Excessive manuring should be avoided as it induces vegetative growth.

Interculture

When sown pure atleast one thorough hand hoeing should be done after third week of sowing.

Harvesting and Threshing

Timely harvesting of sesamum is very important as otherwise shattering of seed takes place. The plants are harvested when they turn pale at maturity and tied into small bundles for shaking. Two shakings are enough to collect the entire produce.

PLANT PROTECTION MEASURES

Insect Pests

The Sesamum Leaf Roller and Pod Borer : The leaf folder folds the leaves together and defoliates the plant by feeding on them. The pod borer damages by boring into and feeding inside the pods. This pest can be controlled by giving 3 sprays of 600, 650 and 725 g of carbaryl (Sevin/Hexavin/Carbavin) 50 WP after 25, 40 and 55 days of sowing in 200, 220 and 240 litres of water per acre, respectively. Hairy caterpillars sometime prove very injurious to the crop. Control measures are same as for bajra (except use of BHC).

Jassids : Cause considerable loss by sucking the sap and transmitting the phyllody which induces malformation of inflorescence. This pest can be controlled by spraying the crop with 200 ml malathion 50 EC in 200 litres of water/acre with manually operated sprayer atleast, twice at 2 to 3 weeks intervals.

Diseases

Sesamum Phyllody : It causes malformation of inflorescence resulting in no grain formation. To control it early sowing in June should be avoided. The diseased plants should be rogued out early in the season and adopt plant protection measures for the control of insect pests.

Blight : Blight is caused by fungus, numerous dark brown lesions are found on the leaves and pods. To control this disease spray the crop with Mancozeb 800 g/acre at 10 to 15 days intervals.

CASTOR

Castor can be grown under varied types of soil and climatic conditions. Its cultivation as a border or mixed crop is practised in some districts. The crop can also be grown on canal banks, bunds and waste lands. The following improved cultivation methods are recommended for raising a good crop of castor.

VARIETIES

Aruna : It is recommended for cultivation under irrigated and rainfed conditions. Its average yield is 7.2 q/acre under irrigated conditions and 3 q/acre under rainfed conditions. It has small size dark brown seeds and contains 50 per cent oil. It bears 3-5 spikes per plant and matures in 140 days.

Castor Haryana No. 1 (CH-1) : This variety has been released recently for cultivation in Haryana State. It is extremely dwarf variety (90-100 cm height) with short internodes, pink red stem colour, bushy appearance, dark green leaves and crowded bearing 5-8 spikes. Its average yield is about 7.2 q/acre. It has small sized dark brown seeds and contains 49 per cent oil. It matures in about 110 days and almost all the spikes mature at the same time.

AGRONOMIC PRACTICES

Soil and its Preparation

Castor grows well on all types of soil. Two or three ploughings followed by planking are considered enough to achieve good germination.

Sowing Time

As a pure crop it should be sown in the 2nd half of July. Early sowing should be avoided, as it results in more vegetative growth.

Seed Rate and Method of Sowing

For securing better yields, the crop should be sown by **kera** or hand dibbled at a depth of 5 cm. A spacing of 60 cm for Aruna and 30 cm for CH-1 between lines and 30 cm between plants is recommended. 5 kg seed is enough for one acre. The seed should be soaked in water for 12 hours prior to sowing.

Manuring

Generally no manuring is done. However, in light soils of poor fertility 15 kg N (60 kg CAN 25%) per acre should be drilled half at sowing and the rest two months after sowing.

Interculture

When sown pure, two hoeings with the help of wheel hand hoe should be given after third and seventh week of sowing.

Irrigation

The crop is sown under rainfed conditions in areas with an annual rainfall of 75 cm or above. Two to three irrigations are required in areas with less than 50 cm rainfall. The Ist irrigation should be given after 1½ months of sowing and the 2nd after 3 months of sowing depending upon rainfall.

Harvesting and Threshing

It is a non-shattering type and the harvesting can be done after the full maturity of the crop. Threshing may be done after it is properly dried by hand beating or by castor sheller.

PLANT PROTECTION MEASURES

Insect Pest

Hairy caterpillars & semi-looper : They are serious pests of castor and devour the foliage. Control measures same as under bajra but do not use BHC.

HINTS FOR MAXIMISING CASTOR YIELD

1. Use seed of variety Aruna and CH-1.
2. Sow the crop in lines at proper spacings.
3. Use recommended plant protection measures at appropriate times.

SUNFLOWER

Introduction

Sunflower crop is photo-insensitive and thus can be grown throughout the year over a greater range of soil conditions with variation in yield, oil content and maturity period. The crop also has an advantage over other oilseed crop which compete with field crops during **rabi** and **kharif** seasons.

The major problems faced are :

(a) Birds damage

The head structure of sunflower plant makes it easily accessible to birds damage because the seeds are usually exposed and the large

heads serve as a perch during birds feeding, thus causing very heavy yield loss. This damage can be eliminated by bringing huge blocks of land under sunflower cultivation so that the birds are spread over a larger area.

(b) Pollination

In the absence of pollinator (Honey bee, bumble bee and wild bee) the pollination is also a problem but this can be tackled by hand pollination which include rubbing of the heads softly with a fine cloth wrapped around the hand, early in the morning.

Taking care of the above two factors the sunflower cultivation can be taken up successfull. It has the following advantages :

1. It can be introduced as a catch crop during summer.
2. Can be fitted into a variety of cropping pattern such as :
   (a) Where wheat is late after toria.
   (b) After harvesting sugarcane.
   (c) After Sept. sown potato or any other period when some crop fails and the fields are found vacant.
3. Sunflower crop does well both in sandy loam and black loam soils.
4. Its oil has a medicinal value.
5. Area can be rapidly increased as the seed multiplication is of the order of 80-100 times as against only 8-10 times in groundnut.

Varieties

HS-1 (Haryana Surajmukhi-1) : It is a selection from EC-68415 and yields significantly higher than the original line. The maturity is homogeneous and the yield range is from 7-8 q/acre. Maturity period varies from 92 to 147 days depending upon the weather conditions.

Modern : It is early maturing variety. It takes about 85 days from sowing to maturity. The yield range is 6-7 q/acre.

Hybrid Varieties

Some of the hybrids namely LSH-3, MSFH-1, MSFH-8, APSH-11 and KBSH-1 are found better in various trials which give 8-10 q/acre average yield.

Time of Sowing

Any time of the year, keeping in view that the crop requires adequate moisture upto 40-45 days of germination and heavy rains should not synchronise with flowering period (50-65 days) after germination.

Higher yield of sunflower can be obtained if the crop is sown from 15th January to end of February. During this period the crop and the yields vary from 6 to 8 q/acre with a maturity period of 128 to 147 days. The crop sown after February end matures in the peak rainy season and the crop quality may be adversely affected due to rain. July sown crop yields about 4-5 q/acre in 95 days. In general, October-November sowings are avoided due to the fear of frost damage.

Seed Rate and Method of Sowing

For hybrids 1.5 to 2.0 kg seed/acre whereas for other varieties 3-4 kg seed/acre is sufficient. The seed may be soaked in water overnight and then dried in the shade. This will also help in removing the unfilled seeds. The crop may be sown in rows 45-60 cm apart. The plant to plant distance being 30 cm. The depth of sowing will mostly depend upon soil moisture normally 3-5 cm will be better.

Fertilizer

24 kg N + 16 kg P_2O_5/acre is recommended for composites as well as for hybrids. Nitrogen should be applied in two splits. Full phosphorus and half nitrogen dose is to be applied at the time of sowing and remaining half should be given at the time of first irrigation. Phosphorus should be applied as single super phosphate.

Interculture

Two hoeings after 3 and 6 weeks of sowing may be given to keep the field free of weeds.

Irrigation

One irrigation at flowering is essential for good seed filling. The total number of irrigations will depend on the time of sowing. So, irrigate the field as and when required.

Harvesting

The stalks near the head when bends and turn yellow the crop is ready for harvesting. The heads are cliffed and dried in the sun after which the threshing is done with sticks and then the winnowing.

Insect-Pests and their Management

1. Cut worm (*Agrotis* spp.)

The pest causes considerable amount of loss to this crop particularly during winter and summer seasons. The caterpillars damage the young plants (upto one month after germination). The caterpillars are nocturnal in habit, therefore, the damage is done during night hours only. The caterpillars cut the young plants at ground level.

Control

(i) Spray the crop with 80 ml fenvalerate 20 EC or 50 ml cypermethrin 25 EC or 150 ml decamethrin 2.8 EC in 100-150 litres of water per acre or dust the crop with 10 kg fenvalerate 0.4% per acre.

(ii) Irrigate the fields, the caterpillars will be killed of drowning effect.

2. Hairy caterpillars *(Spilosoma montana)*

The crop taken in **kharif** season is more prone to the attack of hairy caterpillars particularly during drought years.

The tiny caterpillars feed gregariously and remain confined on the same leaf, on which the eggs are laid, for 5-6 days. Later on the caterpillers start dispersing and cover the whole plant. As the food deplets they migrate to other plants and within a few days entire fields is covered. The pests feed voraciously on the leaves and in case of severe infestation tender stem portion and capitulum may be consumed.

Control

(i) Hand picking and destruction of larvae in gregarious phase is quite easy and sure method to combat the menace of this pest.

(ii) In order to check the migration of the caterpillars from infested to healthy fields a 15 cm wide band of BHC 10% dust should be applied around the infested fields.

(iii) Spray the crop with 500 ml endosulfan 35 EC/quinalphos 25 EC or 250 ml monocrotophos 36 SL or 200 ml DDVP (Nuvan) 76 EC in 250 litres of water per acre.

3. Bird pests

Parrot, dove and crows are the major bird pests of sunflower crop. They feed on sown seeds (dove and crows) and seeds from capitulum (Parrots). The parrots sometimes even destroy peduncles of the flower as a result of which the heads fall down. The birds may cause 100% loss in yield if the field is left unwatched.

Control

The birds should be scared at least during morning and evening hours (from sowing till germination and again from flowering till harvesting). Manual scaring is better over mechanical scaring because after sometimes the birds become used to the mechanical system and thus it looses its effectiveness.

Diseases

Alternaria blight : This disease is caused by a fungus and in **kharif** season the loss may be 15-20 per cent. In the beginning, the lower leaves of the affected plants develop light black, round to elleptical spots measuring approximately 0.2-0.5 cm in diameter. Because of severe infection large number of such spots are formed and defoliation takes place. Affected plant becomes weak and the flowers size is reduced.

Control : As soon as the first symptom is visible, spray the crop with Indofil M-45 (Dithane M–45) at the rate of 500-600 g in 250-300 l of water per acre. If need is there, repeat the spray 2-3 times at 10 days interval.

Head rot : This is a very serious disease. In the beginning back portion of the flowers and adjoining stem show symptoms of the disease. The disease starts with the formation of water soaked lesions which later on become light brown in colour. With the advancement of the disease, the lesion increases in size and also damages the soft tissue. This leads to severe rot at the back of the flower as well as at on the adjoining stem due to which flowers wither and hang on dry stem. Seed formation does not take place in the diseased earhead. Some insects attacking on the flower make injury to the tissues from where general head rot starts.

Control : Spray 500-600 g copper oxychloride or Indofil M-45 after formation of the flower. Repeat the spray 15 days later. To control the insect it is essential to spray the crop after flowering with 400 ml Endosulfan in 200 l water per acre.

Root rot and stem rot : Both these diseases may attack plant at any stage of growth but mostly infection takes place at the time of seed formation in the flowers. The roots and stem of the affected plants become soft. The main stem becomes black at ground level. The stem of such plants topples on the ground and infected plants are dried.

Control : Primarily this is a seed-borne disease and hence before sowing, the seed should be treated with captan or thiram at the rate of 3 g/kg seed. Certain weed also helps in disease spread. therefore, weed should not be allowed in the field.

PULSE CROPS

MOONG, MASH AND COWPEAS

Moong, mash and cowpeas are the important **kharif** pulses grown in Haryana. The average yield of these crops is very low because they are sown under neglected conditions and also because they receive little attention for improvement. However, even with the present varieties, if the farmers adopt improved cultivation practices, the yield of these crops can be stepped up to a considerable extent.

IMPROVED VARIETIES

Moong

K 851 : This variety is recommended both for sowing in summer as well as in **kharif** season. It is semi-spreading with comparatively erect type of plants. It matures in 65-70 days. 80-90 per cent pods mature at a time. Average yield is 3.2-4 q/acre.

Type 44 or Pusa Baisakhi : It is an early maturing type of moong specially valuable for summer (April-June) crop but can also be grown in **kharif** season. Takes about 70 days to mature in **kharif** and 65 in summer. Average yield is 2.5-3.2 q/acre.

Asha : Released in 1991 for general cultivation in irrigated areas during **kharif** season; taller than old varieties; grain medium, smooth and shining green in colour; resistant to yellow mosaic virus disease; higher protein content than K 851; synchronous (80-90%) maturity, maturity duration 75-80 days; average yield 4.5-5.5 q/acre.

Mash

T-9 : This variety is recommended for general cultivation in Haryana. It is a short duration (75 days) variety. It is erect type with long flat leaves and synchronous in maturity. It has bold seed with excellent cooking quality. Average yield is 4-5 q/acre.

Cowpeas

F.S.-68 : This is a short duration grain type, which matures in 65-70 days. It fits in multiple cropping system and is specially suitable for sowing just after wheat or barley in early April. It can also be sown in July just like other **kharif** pulses. Average yield is 3.2 q/acre.

Soil and its Preparation

A well-drained loam to light loam soil is suited for these crops. It has been observed that moong thrives well in lighter soils while mash in heavier soils. The land should be well prepared by giving two to three ploughings followed by sohaga. The land should be levelled and free from clods and weeds.

Sowing Time

The crop should be sown with the advent of monsoon which usually breaks in early July. They can also be taken as summer crop, if assured irrigation is available. In case of summer season the sowing should be completed by 3rd week of March.

Treatment with Rhizobium Culture

There are specific rhizobia cultures for Moong, Mash and Cowpea, etc. The culture packets are available with Department of Microbiology, CCS Haryana Agricultural University, Hisar. The cost of one packet is Rs. 5/- which is sufficient for treatment of one acre of seed. Dissolve 50 g of Gur in two cups (200 ml) of water in an empty bucket. Moisten the seeds required for one acre with gur solution. Sprinkle the Rhizobium culture and mix thoroughly with hand so that seeds are uniformally coated with the culture. Dry the seeds in shade before sowing.

Seed Rate and Method of Sowing

For moong and mash seed rate of 6-8 kg/acre and for cowpeas FS-68, 12 kg seed per acre is recommended. For attaining higher production, proper spacing should be maintained. Too less or too large plant population leads to reduction in yield. Moong, mash and cowpeas should be sown in lines by keeping a distance of 30 to 45 cm. Sowing should be done with **kera** or **pora** method. Intercropping of moong with arhar can be taken successfully.

Thinning

If needed, plants may be thinned out to maintain 7-10 cm plant to plant spacing.

Fertilization

Drill 6 to 8 kg N as starter dose and 16 kg P_2O_5 (100 kg single superphosphate) per acre before sowing by pora.

Weeding and Interculture

Two weedings are recommended to keep the field free from weed infestations. First hoeing at 20-25 days after sowing and 2nd hoeing at 35 to 40 days should be done.

Irrigation

Generally no irrigation is required for these crops but in case of failure of rainfall for a longer period during growing season. the crop should be irrigated. One irrigation at flowering, in absence of any rainfall, helps in increasing the production.

Crop Rotation

Pulses can play a vital role in maximising food production, if due place of crop rotation is given to this group of crops. Moong and urd are short duration crops, require little inputs and give reasonable returns besides enriching the soil fertility, and hence deserve attention in crop rotation practices. **Kharif** fallow should preferably be brought under moong and urd.

Cultivation of Summer Moong

Except the following, the other agronomical package of practices of **kharif** season crop may be adopted for the cultivation of summer moong.

Time of sowing : The best time of sowing of summer moong is whole of March. The sowing should not be delayed beyoud March, otherwise crop will not be harvested before the onset of monsoon and the chances of crop being damaged by monsoon rains are more.

Seed rate and spacing : For summer moong 10 to 12 kg/acre seed should be used. The crop should be sown in lines by keeping a distance of 20-25 cm.

Irrigation : Besides pre-sowing irrigation (paleva), first irrigation after 20-22 days of sowing and subsequent irrigations at an interval of 10-15 days are required.

Harvesting and Threshing

For Type 44 or Pusa Baisakhi, one picking before the final harvest is necessary. In case picking is not possible owing to the non-availability of labour or high costs of labour, the crop should be harvested when

about 80 per cent of the pods mature. For the main kharif-season pulse varieties, no picking is recommended. The crop should be harvested when most of the pods have matured.

PLANT PROTECTION MEASURES

Insect Pests

Hairy caterpillars, flea-beetles, jassids and whiteflies damage this crop. For control of hairy caterpillars use pesticides recommended under bajra. The same will control the flea-beetles. For control of jassid and whiteflies spray 400 ml malathion 50 EC or 250 ml dimethoate (Rogor) 30 EC or 250 ml oxydemeton-methyl (Metasystox) 25 EC or 250 ml formothion (Anthio) 25 EC or 75 ml phosphamidon (Dimecron) 85 SL at 2-3 weeks interval in 250 litres of water/acre with manually operated sprayers.

These sprays will also reduce the losses by mosaic virus.

Diseases

1. Cercospora Leaf Spots : Angular, brown or red coloured spots with grey or brown centre and reddish-purple border are formed on leaves, stalks and pods. Spray the crop with Blitox 50 or Indofil M-45 at the rate of 600-800 g/acre in 400 litres of water.

2. Bacterial Leaf Spot : Appear as water soaked dots on the under-surface of the leaf which remain small in size and the surrounding tissues become necrotic. Spray the crop with copper oxychloride 600-800 gm in 200 lt. of water per acre.

3. Root Rot : Affected plants show stunting and yellowing; roots begin to shred and rot leading to death of the plant. For its control treat seed with thiram @ 4 g/kg seed. Follow crop rotations.

4. Yellow Mosaic : Affected plants show yellow and green areas on leaves; badly affected leaves turn completely yellow; yields considerably reduced. In certain areas of Ambala and Karnal this disease may affect 90 per cent.

Control

1. For the control of white fly, which is vector for this disease spray the crop thrice in 250 litre of water per acre 20-25 days after sowing with 250 ml dimethoate 30 EC (Rogor) or 250 ml oxydemeton

methyl 25 EC (Metasystox) or 250 ml formothion 25 EC (Anthio) or 75 ml phosphamidon 85 WSC (Dimecron) or 400 ml malathion 50 EC at 10-15 days interval.

2. Rogue out infected plants as and when visible.

3. Destroy weeds in and around the crop.

4. Grow disease resistant variety such as Asha.

ARHAR

Arhar is one of the highest yielding pulse crop and has a very wide range of agroclimatic adaptation. It is possible to introduce this crop throughout the state with a view to exploit the hardiness of this crop in rainfed areas as also to grow a successful alternative kharif crop in the intensively cropped areas.

IMPROVED VARIETIES

MANAK : Also known as H-77-216 and recently released for general cultivation in the State. This variety is about 8-10 days earlier maturing than UPAS-120. It grows medium tall and plants are indeterminate in growth habit. This variety is also tolerant to drought and wide range of temp°. It does fairly well even under late sowing (upto first fortnight of July). Average yield is 7.5 q/acre.

PARAS (H 82-1) : This variety has been under the popular name "PARAS". It grows medium tall and growth habit is indeterminate and semi-spreading. This variety bears more number of branches and pods. The seeds are small, smooth and brown in colour. Being vigorous, it also performs well under late sown conditions. The maturity duration ranges from 135 to 140 days. Its average yield is 7-8 q/acre.

UPAS-120 : This is also medium tall in height and matures in 130 to 140 days. It has indeterminate habit of growth with the result that blooming period is considerably prolonged. It has higher number of branches which droop at maturity. Its pods are well distributed along the length of branches. Average yield is 6 q/acre.

Type 21 : This is a late maturing type, taking about 150 to 160 days to mature. This is tall and highly branched. It is indeterminate in flowering behaviour, with the result that farmer has to choose the proper time of harvesting the crop according to the proportion of matured pods on the plant. Its seeds are slightly bolder than those of above mentioned

varieties. After harvesting the crop of T 21, it is possible to take only a late crop of wheat. However, this variety has a higher yield potential than above mentioned varieties and its average yield is above 7-8 quintals per acre. It should be planted early in the sowing season (before mid June).

AGRONOMIC PRACTICES

Soil and its Preparation

Well-drained loam to light loam soil is more suitable. Give 2-3 ploughings followed by planking for the control of weeds and removing the clods in the field.

Time of Sowing

Under irrigated conditions, where double cropping system is followed, the time of sowing for variety T-21 is from middle of March to middle of June and for variety UPAS-120 from middle of March to first week of July. White Manak and Paras varieties should be sown for June to mid July. However, the optimum time of sowing for both varieties falls in the first fortnight of April for higher production. Whereas under rainfed conditions, all the recommended varieties should be sown as early as possible after the onset of monsoon.

Inoculation of Seed

Like other pulse crops, Arhar seed should also be inoculated with Rhizobium culture. It should be done just before sowing as mentioned in case of moong.

Seed Rate and Method of Sowing

For pure crop all the recommended varieties should be sown in rows about 40 cm apart using 5-6 kg seed/acre. However, for inter-cropping of short duration crops the row spacing should be 50 cm.

Intercropping

Arhar when sown from middle of March to middle of April by keeping inter-row distance of 75 cm, two rows of moong variety K 851 can be planted between two rows of arhar. Similarly, plantings with the same spacing two rows of cowpea's variety HFC 42-1 should be sown between them. These intercrops can be harvested in about 50 to 75 days. By this system of planting, arhar yield is not adversely

affected rather an additional yield approximately equal to the sole crop of moong/cowpea is obtained. Arhar when spaced 50 cm apart one row of moong or cowpea can also be profitably planted during the above mentioned time of sowing.

Following are the advantages of this intercropping system :

1. Two crops can be raised simultaneously with the input cost of one crop.

2. By sowing summer arhar the plants get established well before the oneset of monsoon and develop resistance against the excessive rains and drought.

3. Less infestation of weeds during summer as well as in **kharif** due to the smothering effect of crop during both the seasons.

4. Early maturity of arhar by about 15 days facilitates timely preparation of field for subsequent wheat sowings.

5. Higher yields and net returns than **kharif** sown arhar.

Fertilizer

For getting higher production of Arhar sown pure as well as in mixture apply 8 kg N and 16 kg P_2O_5 (100 kg single super phosphate) per acre at the time of sowing.

Interculture

For the control of weeds, two weedings and hoeing should be given after 25 and 45 days after sowing.

Irrigation

Irrigation, if possible, must be given once at commencement of flowering. Irrigate the crop at about 30-35 days growth stage particularly when intercrop is taken.

Insect-Pests

Control of Pod Borers in Arhar : Spray the crop with 600 ml endosulfan (Thiodan/Thiotox/Endocel) 35 EC or 300 ml monocrotophos (Nuvacron/Monocil) 36 SL or 75 ml cypermethrin 25 EC or 120 ml fenvalerate 20 EC or 215 ml deltamethrin 2.8 EC or 600 ml quinalphos

25 EC in 300 litres of water per acre at 50% pod formation. To overcome difficulty of spraying, sowing should be done in bands of 7 meters width leaving 3 meter space in between 2 bands of arhar for proper handling of sprayer. Spray arhar crop with foot sprayer from like urd, moong etc. can be taken as an intercrop, in the space both sides. Crop between two bands of Arhar.

Note : Second spray may be done, if necessary, after 15 days of first spray.

HINTS FOR MAXIMISING YIELD

(i) Use improved varieties.

(ii) Sow only treated seed with Rhizobium culture.

(iii) Apply recommended doses of fertilizers.

(iv) Use pesticides for controlling insect pests.

(v) Use seeds from disease free plants.

SOYBEAN

Soybean is an important industrial crop and is consumed in antibiotic, food processing and vegetable ghee processing factories in the country. Till recently its cultivation was mostly confined to hilly areas. Farmers can attain good yield by adopting the recommended practices in plains also.

IMPROVED VARIETIES

Bragg : It is provisionally recommended for cultivation in the plains till a mosaic resistant variety becomes available. Although this variety yields 9 q/acre at the experiment station but at the farmer's fields its yield was around 5 q/acre. Some of the reasons for low yield at the farmer's fields were poor germination, high infestation of disease and failure in use of soybean culture. The seed is bold and of cream colour, contains 20% oil and 38% protein and matures in about 120-125 days.

PK-416 : The variety PK-416 is promising for Haryana State. The growth habit is determinate. Its seeds are medium bold, oval shaped and yellow with brown hilum. This variety is tolerant to yellow mosaic virus and rhizoctonia aerial blight and resistant to

bacterial pustules. Maturity duration is 120-125 days and average yield is 10-12 q/acre.

PK-472 : This variety is also promising and suitable for Haryana. Its foliage colour is dark green and growth habit is determinate. The seeds are bold, smooth and yellow with brown hilum. It is tolerant to pod shattering and resistant to bacterial pustules, rhizoctonia aerial blight and yellow mosaic virus. This variety matures in 120-125 days. Its average yield is 10-12 q/acre.

PK-564 : This variety has also been found suitable for general cultivation in Haryana. The plant is sturdy and growth habit is determinate. Its seeds are medium, oval shaped and yellow with dark brown hilum. This variety possesses resistance to yellow mosaic virus and bacterial pustules and tolerance to rhizoctonia aerial blight. Maturity duration is 120-125 days and average yield is 10-12 q/acre.

AGRONOMIC PRACTICES

Soil and its Preparation

Soybean can be grown on a wide range of soils but thrives best on fertile well-drained loamy soil. The soil pH of 6.0 to 6.5 is the best for nodulating bacteria for efficient conversion of nitrogen from the air. Water logging is harmful to the crop. The land should be prepared by giving two ploughings followed by plankings after the previous crop is removed. However, the land should be free from clods and should be fertile to ensure good germination.

Sowing Time

Soybean should be sown from the end of June to the beginning of July. As its germination is adversely affected by heavy rains immediately following sowing, it should preferably be sown with irrigation towards the end of June when the monsoon has not yet set in.

Seed Treatment with Rhizobium Culture

It is emphasized that seed inoculation by specific Rhizobium culture is the must to supplement the nitrogen of crop. If inoculation is not done crop requires high doses of nitrogen. Rhizobium culture is available from the Department of Microbiology, HAU, Hisar. Culture should be properly used according to the method of treatment as in case of moong.

Seed Rate and Method of Sowing

30 kg per acre seed rate is recommended to ensure proper stand. The seed should be sown in rows 45 cm apart and 2.5 cm deep in optimum moisture. Sowing of two rows of soybean spaced 30 cm apart followed by one row of maize is a good cropping system from the point of view of yield, economic returns and maintenance of soil fertility.

Fertilizers

10 kg N (40 kg CAN 25%) and 32 kg P_2O_5 (200 kg single superphosphate) per acre is required for getting maximum yield. The entire fertilizer should be applied at sowing. It is further emphasised that tke seed inoculation is the cheapest and best source of meeting the nitrogen requirement of the crop otherwise much more nitrogen will have to be applied.

Interculture

It is essential to control the weeds effectively by weeding twice preferably 15 and 30 days after germination to avoid competition with the crop.

Irrigation

The crop requires three to four irrigations in plains especially in case of failure of rains.

Harvesting and Threshing

The crop is harvested when the leaves fall off and pods change colour. Harvest the crop immediately after maturity to avoid any loss by shattering the seeds.

Storage of Seed

The seed should be stored at a moisture content not exceeding 11 per cent in dry bins or in bags kept on wood racks. If the seed is properly stored it remains viable for about a year. The seed can, however, be stored for a longer period for other uses.

PLANT PROTECTION MEASURES

Insect Pests

As under moong.

Disease

Bragg is susceptible to mosaic virus. The damage from the disease can be minimised by rigid spraying mentioned in detail under insect pests.

HINTS FOR MAXIMISING YIELD

(i) Use improved varieties.

(ii) Treat seed with rhizobium culture before sowing.

(iii) Use recommended doses of fertilizer.

(iv) Follow spraying schedule for controlling pests and diseases.

(v) Harvest crop timely to avoid shredding of grains.

FODDER CROPS

SORGHUM

Sorghum is the most important kharif fodder crop which may be grown over a wide range of soil types. It is nutritious as well as palatable to cattle and can be fed green, dry or in silage form. Two crops of sorghum may be taken—one in March-June and the other during monsoon , i.e., July-October or November. It is also possible to sow Sudan grass at the end of March and continue taking cutting up to the end of October from the same crop. Thus, sorghum provides forage during the fodder scarcity periods of May-June and Oct.-Nov. However, to avoid the possible danger of H. C. N. poisoning, the sorghum may be sown during June-July while Sudan grass may be sown earlier i.e. end of March. Practices for successful and profitable cultivation of sorghum are given below :

IMPROVED VARIETIES

Several varieties of sorghum are recommended for cultivation in the different areas of Haryana. Choose any one, suitable to your area :

Sr. No.	Variety	Area for which recommended	Special attributes
1	2	3	4
1.	J. S. 20	Arid and rainfed areas of Haryana	Good for early sowing in March. Yields 168 q/acre.
2.	H.C. 136	All irrigated areas of Haryana	It is tall, sweet, juicy and medium thick stemmed. Leaves are long and broad with green mid rib and remain green upto maturity. On an average, it gives green fodder yield of 200-240 q/acre and 60-80 q/acre of dry matter. It yields 4-5 quintals of seed per acre and its seed is bold and white.

1	2	3	4
3.	Sweet Sudangrass 59-3	Irrigated plains of Haryana	Sweet and high quality fodder during scarcity period, remains green for longer period. Yields 300 q/acre during May to Nov. in 3-4 cuttings.
4.	H. C.-171	All irrigated areas of Haryana	It is a medium tall and sweet stemmed variety with very broad leaves. It is resistant to all kinds of foliar diseases and better in quality. It provides around 200 q/acre of green fodder and 65-70 q/acre of dry matter. It yields about 5 q/acre of seed which is small in size and creamish white in colour. It is resistant to mites as well and matures in 110-112 days (seed to seed).
5.	H.C.-260	-do-	It is a tall and non-sweet variety with long and broad leaves. It matures in 85-88 days (seed to seed) and remains green upto maturity. It is resistant to red leaf spot diseases and is suitable for **Karabi** making. On an average it gives 180-200 q/acre of green fodder and 70-75 q/acre of dry matter. It can give 6-6.5 q/acre of seed with proper management. Seed is medium bold and white in colour.

AGRONOMIC PRACTICES

Soil and its Preparation

Thorough preparation of field is essential to get rid of weeds as well as to enable the crop to attain fast initial growth. The crop growth on well-prepared soil is about 50-70 per cent better than that on badly prepared soils. Therefore, tendency to neglect this aspect for fodder crop should be stopped forthwith. In the irrigated areas one ploughing

by mould board plough followed by ploughings with a **desi** plough (one (across the other) should invariably be given before sowing.

Sowing Time

For summer sowing March 20 to April 10 is the best period while for monsoon season, sow at the first opportunity, preferably between June 25 and July 10. Sudan grass should be sown in April.

Seed Rate and Method of Sowing

Do not broadcast the seed. Sow by drill or pora in rows 25 cm apart at the rate of 20-24 kg seed per acre for summer and 16-20 kg per acre for kharif sowing and 12-14 kg per acre for Sudan grass.

Fertilizers

For low rainfall and rainfed areas 20 kg N per acre should be applied at the time of sowing. Drill all the fertilizer in rows before sowing. For high rainfall or irrigated areas apply 20 kg N per acre at the sowing time. However, another 10 kg N per acre should be applied one month later. For Sudan grass apply 10 kg N (40 kg CAN 25%) per acre after each cutting. In sandy soil areas having low P content, 6 kg P_2O_5/acre (40 kg single superphosphate) may be applied at the time of sowing.

Interculture

One good hoeing preferably by **khurpa**, about 15-20 days after germination is very beneficial. Spray atrazine (50% WP) at the rate of 200 g/acre in 250 l of water from 7 to 15 days after sowing for control of weeds.

Irrigation

About five irrigations during summer season for early crop (March-June), 1-2 depending upon rains during monsoon, may be necessary for crop sown in June-July.

PLANT PROTECTION MEASURES

Insect Pests

Sorghum is attacked by shoot-fly in early stages of growth, by stem borer during the entire growing period and by the midge during the earing stage.

(i) Shoot fly attacks the crop from March to mid May and mid July to September. It is, therefore, desirable to sow the crop from mid May to June. Use high seed rate, (10% more), remove the plants with dead-hearts (formed by shoot fly as well as stem borer) at weekly interval, and destroy them. In severe attack, spray 300 ml endosulphan 35 EC in 150 litre water per acre.

(ii) Stem borer is a major pest of sorghum & its attack starts 15 days after germination. In young crop, growing shoot dries while in grown up crop, caterpillars found feeding inside the stem. For its control, spray 400 ml endosulphan 35 EC or 400 g carbaryl 50 W. P. in 200 litres of water after 20 days of sowing & repeat spray 10 days after first spray. Deep ploughing after harvest is essential.

(iii) For checking midge damage in the seed crop, spray the earheads with 500 ml endosulfan (Thiodan/Thiotox/Endocel) 35 EC in 250 litres of water per acre at 90 per cent earhead emergence. If required, repeat the spray after 15 days.

Diseases

Grain smut : The affected grains are malformed, discoloured and contain black spore masses. This disease can be controlled by treating the seed before sowing with sulphur dust @ 1 : 250 or with Emisan 2 g/ kg seed.

Red leaf spot : Irregular, tan coloured spots with reddish brown margins appear on leaves. Improve soil fertility and eradicate **Baru** grass.

HINTS FOR MAXIMISING YIELD

(i) Sow appropriate varieties under specific agroclimatic conditions with proper seed rate and spacing.

(ii) Prepare seed bed thoroughly and use adequate fertilizers.

(iii) Irrigate the crop when necessary.

(iv) Control the crop pests and diseases.

BAJRA

Among annual summer forage crops, Bajra is the highest yielder. Bajra, being leafy and succulent, is palatable and satisfactory in protein content. As compared to other forage crops, it grows very rapidly. Since Bajra does not contain HCN, it is a safe summer fodder.

VARIETIES

F_2 seed of any of the recommended hybrid gives more fodder than the seeds of local varieties.

Soil and its Preparation

Sandy loam soil is most suited for this crop. Two-three ploughings are sufficient but the seed-bed should be fine for good germination.

Sowing Time

The sowing of Bajra should be done in the end of March or in the beginning of April so as to provide green fodder in the scarcity period of May-June.

Seed Rate and Method of Sowing

The crop should be sown by using 3-4 kg seed per acre in lines 30 cm apart. The seed should be sown by **pora**. In case Bajra is to be sown as mixed crop, a seed rate of 2-2.5 kg of bajra and 5 kg of cowpea will be enough for one acre. The sowing should be done in proper moisture in lines 30 cm apart by 'Pora or Kera' method in the ratio of 2 : 1 (two rows of bajra and one row of cowpea).

Fertilization

Bajra, being cereal responds well to nitrogenous fertilizers. 20 kg N per acre should be drilled at the time sowing, while 10 kg N should be topdressed one month after sowing. In sandy soil areas having low P content 6 kg P_2O_5/acre may be applied at the time of sowing.

Irrigation

Being summer season crop it requires three-four irrigations.

Harvesting

It is ready for harvesting after 50-55 days of sowing. It yields about 160 quintals green fodder per acre. To make the fodder more nutritious it is recommended that cowpeas should be sown mixed with bajra.

COWPEAS

Cultivation of cowpeas is recommended for irrigated areas. It is generally grown in mixture with jowar, bajra/maize, etc. to enhance the green fodder yield and supplement the nutritive value of non-leguminous fodders. The crop is recommended for feeding the dairy cattle to maintain a good flow of milk during summer.

IMPROVED VARIETIES

FOS 1 : It is spreading in nature and forms long thick vines. Its leaves and pods are broad and light green in colour. It has bold seeds of buff colour with dark specks on it. It gives fodder yield of 100 q/acre.

No. 10 : It is semi-erect in nature and forms thin vines. Its leaves are medium in size and pods are dark green in colour. It has seed of medium size and light brown in colour. It gives fodder yield of 120 q/acre.

HFC 42-1 : It is erect growing variety, having dark-green leaves. Its grains are small and white in colour. April sown crop gives two cuttings. It is recommended for sowing as a mixed crop with Jowar and Bajra. It gives fodder yield of 130-140 q/acre.

AGRONOMIC PRACTICES

Soil and its Preparation

Land should be levelled and well-drained. Loam soils are found to be conducive to good crop growth. Two harrowings should be done for soil preparation.

Sowing Time

Sowing time extends from March to mid July. In irrigated areas, the sowing should be done in Ist week of May while in rainfed areas, it should be sown at the commencement of monsoon.

Seed Rate and Method of Sowing

The seed should be sown by **pora** or drill at the rate of 16-20 kg/ acre in rows 30 cm apart and planked soon after to conserve the soil moisture. When sown in mixture its seed rate should be one-third.

Treatment of Seed with Rhizobium Culture

The seed should be treated with specific Rhizobium culture available for this crop from the Deptt. of Microbiology, CCSHAU, Hisar. Method of treatment is the same as in case of Moong.

Fertilizers

It is sufficient to give a dose of 10 kg N and 25 kg P_2O_5 per acre before sowing by drilling in rows. Being a legume, it does not need much nitrogen.

Interculture

One or two hoeings with kasola should be carried out to check the growth of weeds.

Irrigation

The crop sown in May needs fortnightly irrigations till advent of monsoon. In all, this crop needs 4-5 irrigations.

Harvesting

Cowpea may give two cuttings-first after 55 days of sowing and second cutting at flowering stage. By adopting this practice not only regular supply of green forage in summer is maintained but extra green forage yield is also obtained.

PLANT PROTECTION MEASURES

Jassid attacks the crop in dry weather. It is controlled by spray of 200 ml of malathion 50 EC in 200 litres of water per acre with a manually operated sprayer. If the crop is grown for fodder, do not feed the treated crop to cattle within one week of spraying.

GUAR

It is a very valuable fodder crop for the rainfed areas because it is tolerant to drought. Being a legume, it is nutritious and also enriches the soil. It can be grown alone or mixed with Jowar, Bajra, etc.

IMPROVED VARIETIES

FS 277 : Its plants are erect-growing without branches. It can be sown mixed with Bajra. It gives 110-120 qtl. green fodder per acre.

HFG 119 : It is a new forage variety. It is high yielding, tall and branched with pubescent broad dark green leaves with serrated margin. Leaves per plant in HFG 119 are almost double than those of FS 277. It has high leaf/stem ratio and possesses high degree of tolerance to Alternaria leaf spot and moderately resistant to bacterial blight. It outyielded FS 277 both in green and dry fodder yield by a margin of 14 per cent and 12 per cent, respectively. It gives 120-130 q green fodder per acre.

HFG 156 : It was released for fodder purpose for whole of country by the Central Seed Committee in 1988. It is tall and branched with the pubescent leaves and serrated leaf margin. It becomes ready for fodder in 70 days after sowing. It is moderately resistant to bacterial blight. On an average, it outyields HFG 119 in both green and dry fodder production by the margin of 10 and 15%, respectively. It gives 130-140 q/acre green fodder yield on an average.

AGRONOMIC PRACTICES

Soil and its Preparation

It grows well on well-drained medium to light soils. No special preparation is needed except one or two ploughings and a planking.

Sowing Time

The crop may be sown from April onward up to middle of July. The early sown crop makes luxuriant growth under irrigated conditions. Rainy season crop sown in July is cultivated mostly as rainfed crop.

Seed Rate and Method of Sowing

A seed rate of 16 kg for HFG 119 and 22 kg/acre for FS 277 is enough. The seed should be sown by **kera** under irrigated conditions and by **pora** in the dry farming areas.

Treatment of Seed with Rhizobium Culture

The seed should be treated with specific Rhizobium culture available for this crop from the Deptt. of Microbiology, CCSHAU, Hisar. Method of treatment is the same as in case of Moong.

Fertilizers

Twenty kg P_2O_5 and 8 kg nitrogen per acre should be applied at sowing time.

Irrigation

Early sown crop requires 1-2 irrigations, while July sown crop generally does not require any irrigation.

PLANT PROTECTION MEASURES

Jassid attack begins early on this crop. Control measures are same as for cowpeas.

GIANT NAPIER GRASS

It is vegetatively propagated, bajra like grass, with a tremendous yield potential. It is perennial but yields most of the fodder during warm and wet months, i. e., March to Oct. It is practically free from any disease or pest.

Napier Bajra Hybrid 21 : It is one of the highest yielding variety of this grass.

AGRONOMIC PRACTICES

Planting

It is propagated vegetatively by root-stocks or stem cuttings. About 11,000 root stocks of stem cuttings (each about 50 cm long with 2-3 buds) per acre are planted. Half part of the sett is allowed to remain in air while the rest of the portion is buried in soil. It should be planted with 75 cm distance from row to row and 60 cm from plant to plant. It can be planted during warm season from March to September. However, the best time for planting is March or with the advent of monsoon.

Fertilizers

During first year 20 cartloads of farm yard manure or compost per acre should be applied before planting. Apply 12 kg nitrogen per acre after each cutting. Apply 20 kg nitrogen per acre in the second year after each cutting.

Irrigation

It needs frequent irrigation. During hot and dry months irrigation may be given at an interval of 10 to 15 days. During monsoon stagnation of water should be avoided in the field.

Interculture

After each harvest the crop should be cultivated with munna plough to keep the soil loose, friable and free of weeds.

Harvesting

First cutting is ready about two months after planting. It is ready for subsequent cuttings after every 45 days, during the growing season. The growth is checked in winter months when the cold is very severe, but starts sprouting again as soon as it warms up. It yield about 600 quintals/ acre in a year.

HINTS FOR MAXIMISING FODDER YIELD

(i) Prepare the soil thoroughly.

(ii) Plant root stocks in March.

(iii) Use about 8900 root stocks or stem cuttings per acre and plant at 75 cm between row to row and 60 cm plant to plant distance.

(iv) Apply recommended doses of fertilizers.

(v) Frequent irrigations.

MEDICINAL AND AROMATIC PLANTS

ROSHAGRASS

Roshagrass has been found a useful medicinal crop. It can be grown successfully in irrigated areas. To fetch a good yield of roshagrass the following package of practices should be adopted.

Climate and Soil

It can be grown on different soil types but it prefers light loam to clay type of soil. Hot and dry weather throughout its growth suits better. Water stagnation should be avoided.

Nursery Preparation

Nursery is raised in the month of May-June. 10 meter long, 1 meter broad and 30 cm raised nursery is prepared. 15-20 nurseries of these dimensions are sufficient for planting one hectare of land. 2/3 part of each nursery is filled with soil and rest 1/3 part is field with F.Y.M., and 20 gm B.H.C. (10%) should also be added to avoid termite attack. 5-6 kg seed/hectare is enough. During sowing of nursery 5"-6" row to row distance is kept. For control of root rot disease spray 0.3% Brasicol solution. After 35-40 days of sowing seedlings attain a height of 5"-6". At this stage the seedlings are ready for transplanting.

Field Preparation

The field must be levelled, free from clodes and objectionable weeds. For having such type of field 2-3 ploughings are done with desi plough followed by planking. One ploughing should be done by soil turning plough followed by planking. The weeds and stubbles of previous crop should be picked up by manual labour and burnt in one corner of the field.

Variety R. H. 49

Manures & Fertilizers

Field must be levelled and well pulverised. 40-50 cartloads F.Y.M. and 20 kg B. H. C. (10%) per hectare should be mixed up with

the soil at the time of last ploughing. There should be enough moisture in the field at the time of transplanting of seedlings. 20 kg N+40 kg P_2O_5 and 40 kg K_2O/ha should be applied at the time of transplanting. Thereafter 20 kg N/ha should be broadcasted in the months of Feb.-March and June-July.

Transplanting

Transplanting of seedlings is done in the month of July and August. Row to row distance is kept 24" (2 feet or 60 cm) and 12" (1 foot or 30 cm) between plant to plant is maintained. Just after transplanting of seedlings irrigate the field so that the roots can set and establish in the field easily. Avoid stagnation of excess water for more than few hours.

Irrigation

After transplanting of seedlings, 2-3 irrigations should be given at an interval of 15-20 days, so that the seedlings should set their roots in the soil. Do not allow to stand extra water in the field for more than few hours. To maintain the moisture in the field, irrigate the field at 15-20 days interval in summer season and at one month interval in winter season. In this way 10-12 irrigations are sufficient for a complete crop season.

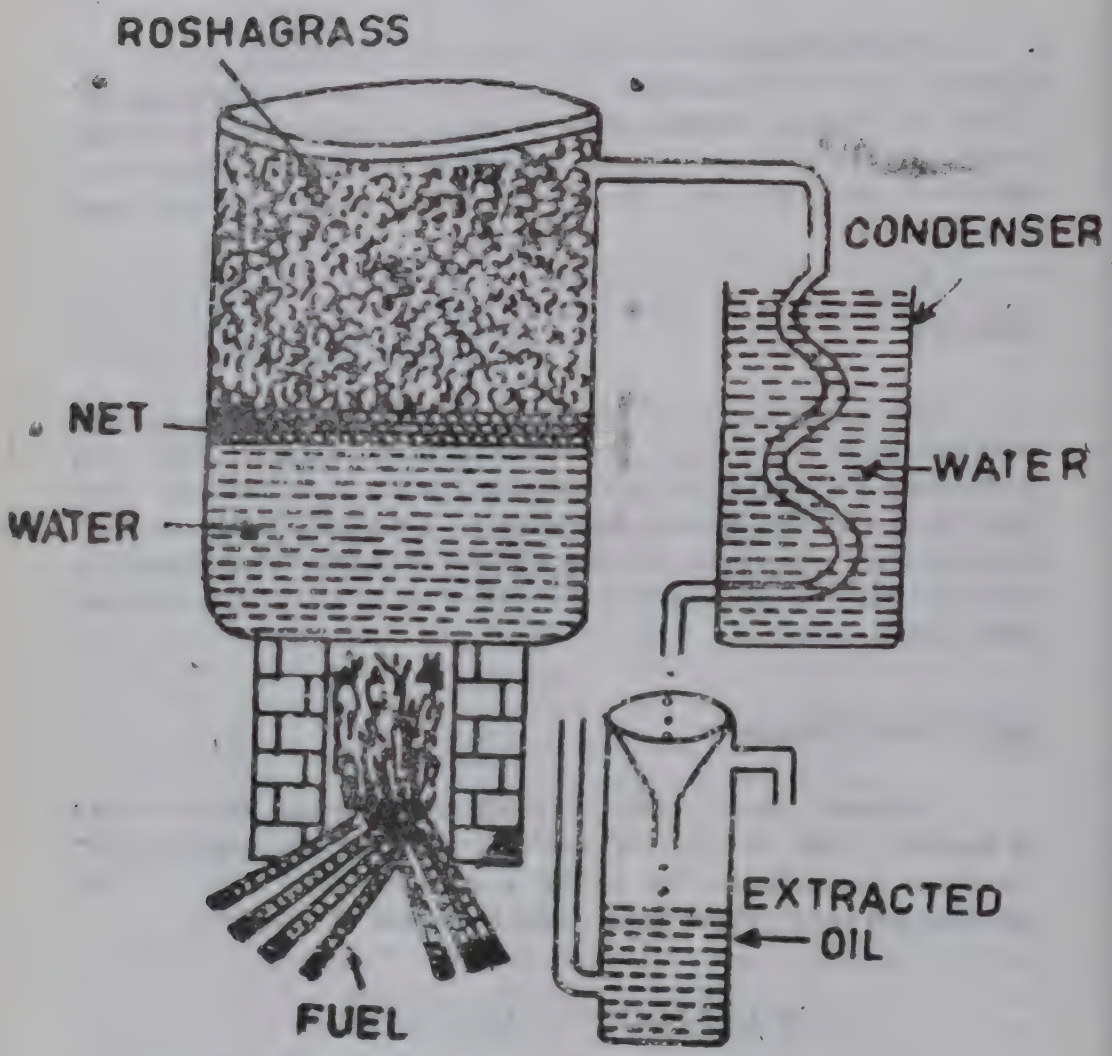
Inter-Cultural Operations

To have a good quality of produce/oil, the field should always be kept free from all kind of weeds. 2-3 hoeings and weedings after irrigations are sufficient for having a good growth of plants. When plants attain 1.0-1.5 meter height, there is no need of weeding.

PLANT PROTECTION MEASURES

Sometimes spider attacks this crop. The leaves become yellowish. The insects are found moving on lower side of leaves and net formed by them is also visible. The growth of plants is checked and the whole field in the beginning becomes yellowish and later on turns brownish in colour. To control this attack spray 0.2% Metasystox. If necessary, spray after 15 days second time.

OIL EXTRACTION UNIT



Harvesting

Under well and systematic management three cuttings can be obtained from this crop in a year. One in the month of Oct.-November, 2nd in the month of May-June and third & last cutting in the month of August-September. On an average 250-300 q/ha green herb yield can be obtained. Its average oil yield is 60-80 kg/ha. It gives cuttings upto 4-5 year after transplanting.

Income

On the basis of Geraniol content in oil, the price of oil is fixed. Roshagrass has about 75% or above Geraniol. At present the price of oil is Rs. 380/kg. So a farmer can earn Rs. 16800-22400/ha in a year. This crop gives a good return in comparison to other crops.

Uses

Roshagrass oil is used in preparation of different perfumes, soaps, *agarbatti* and *dhupbatti*. Besides it is also used as medicine e. g. pain in joints, skin diseases and to cure injuries. Its residue after oil extraction is used as fuel. Its green herb can be fed to animals after mixing with other green fodder. It becomes dormant during winter season. Any **rabi** fodder crop of short durations which require higher quantity of water can be grown between the lines of roshagrass. In this way an additional income can be obtained by planting a **rabi** crop.

Extraction Process

Its oil is extracted by distilation process. The crop should be harvested at flowering. The plant is harvested from 10-15 cm above the soil surface and complete plant is put in a big drum in which water is filled in lower portion. After filling the grass the drum is made complete air tight. From this drum a pipe is taken out at bottom through the condensor. Water is filled in condensor and is to be changed from time to time when required. By heating through furnace the water is boiled. The vapours and oil both converted into steam and after passing through condensor changed into liquid form. Oil is lighter than water. After few hours it can be separated.

In this way, from a machine of 5 quintal capacity two rounds can be completed in a day. The oil of the crop from 4-5 hectares can be distilled in one month of period.

ISABGOL

Isabgol (Plantago ovata) is found to be useful crop for cultivation in Haryana state. It has been observed on the basis of experiments done during last 4-5 years that it can be grown in water scarcity areas also. It is a major cash crop of Gujarat state and grown under 16000 ha of land and its husk and seed worth about Rs. 17 crores is exported annually. Thus, this is a very good crop to earn foreign exchange. It is very useful for the cultivation in sandy and less productive soils of Haryana. The following points should be taken into consideration for its cultivation :

Climate

It requires cool and dry weather at the time of growth and dry at the time of its maturity. The rainfall at the time of maturity damages a lot by shattering the seed and destroys the husk which directly affects quality and yield of this crop.

Soil

Light loam soil is very much suitable for this crop with good drainage system.

Variety : HI-5

Time of Sowing

Isabgol is a crop of rabi season and last fortnight of October to Ist week of November is the best time for its sowing.

Method of Sowing and Seed Rate

The crop can be sown either by broadcasting seeds in well moist field or in lines 9 inches apart. Seed at the rate of 4 kg/ha in broadcasting and 7.5 kg/ha in line sowing will be sufficient. The seed should be slightly covered with soil with the help of light planking after sowing. The crop can also be sown by broadcasting the seed in the field and followed by very light planking.

Fertilizers

45 kg nitrogen and 15 kg phosphorus/hectare is sufficient for this crop. The nitrogen should be splitted into two doses. Half dose of nitrogen and full dose of phosphorus should be applied as basal dose at the time of field preparation just before sowing. While the rest of nitrogen should be top dressed after first irrigation.

Irrigations

If seed germination is satisfactory, then 2-3 irrigations are enough for raising good crop. First irrigation is required after 25-30 days of sowing and second and third can be applied at one month interval.

Interculture Operations

1-2 early hoeing and weedings are sufficient to have a weed-free crop as it is a slow growing and dwarf crop having a height of only 35-40 cm.

Plant Protection

Although the crop is free from any serious disease except that downy-mildew sometimes appears in the early stages which later on affect the spike/ear as in case of bajra. To avoid this, the seed should be treated with Thiram or P.M.A. at the rate of 3 g/kg of seed before sowing. Later on, the crop should be sprayed with Diethane M-45 0.2 per cent solution 2-3 times at 15 days intervals.

Crop Duration and Seed Yield

The crop is ready for harvesting after 140-150 days when leaves turn yellow, spikes look brown in colour and the grains come out of spikes if pressed between thumb and fingers. Thrashing can be done either by beating with the help of a rod or simply by rubbing with the hands and then cleaning thereof. Seed yield upto 10-12 q/ha can be obtained from a good crop.

MULLATHI

Mullathi/Liquorice (Glycyrrhiza glabra) is a perennial medicinal plant. The root portion of the plant is used for preparation of number of medicines specially coughsyrups. The crop is propagated through roots. It matures in a period of 2½ years. After maturity, the crop is dug out and used for different purposes. After long and untiring efforts by the scientists of CCS Haryana Agricultural University it has been made possible to cultivate this crop in Haryana on large scale by adopting the following cultural practices :

Soil and Climate

It requires dry hot climate. Sandy loam soil is best for its cultivation.

Land Preparation and Fertilizer

The field should be well levelled. Two to three ploughings by Desi plough followed by planking are enough. There should be provision for proper drainage. During land preparation, 16-20 cart load of F.Y.M. should be mixed properly in the soil. At the time of last ploughing, Nitrogen and Phosphorus @ 8 and 16 kg/acre should be applied, respectively. Top dress the remaining 8 kg Nitrogen after one month of the germination. Thereafter, 16 kg Nitrogen/acre/annum should be applied in the month of March. B.H.C. (10%) can be used to control the termites.

Variety

Haryana Mullathi No. 1

Time and Method of Sowing

The best time of sowing in February-March and July-August. In irrigated areas, it can be sown in the month of February-March. Otherwise it is sown on the first onset of monsoon and up to the month of July-August. Root cuttings of 15-20 cm length are sown at a distance of 45 cm from plant to plant and 90 cm from line to line. The 3/4th portion of the root cuttings should be put under soil and 1/4th above the ground. Just after sowing the field must be lightly irrigated. The same process of irrigation should be repeated till germination at 15-20 days interval. This will activate the process of germination of roots. Stagnation of excess water should be avoided.

Irrigation

In the initial stage of germination and growth of crop two to three irrigations are required. Later on, irrigate the crop according to need. In the first year generally 5-6 irrigations are required.

Inter Cultural Operations

Two to three hoeings and weedings are enough for having a good crop. The weeds should be removed from the lines carefully with hands. In the months of January and February one hoeing is necessary.

Insect-Pests and Diseases

Generally, it is not attacked by diseases. But sometimes leaf spot disease may occur. Leaves turn yellowish and finally fall down on soil. To control this disease, spray 0.2% Diethane M-45.

Cotton grey weevil and aphid may also attack this crop. For their control, spray Malathion or Endosulphan @ 500 ml (in 250 l water) per acre.

Yield

After 2½-3 years of sowing of crop, the roots get ready for harvesting. The roots are dug out with the help of disc plough followed by cultivatior. Roots should be picked up from soil. This process should be repeated 3-4 times to collect the roots completely from the soil. The soil should be dug upto the depth of 50-60 cm. The average dry root yield is 30-32 q/acre from a good crop. The produce can be sold to any Pharmacy in Haryana and its adjoining states.

Storage

The dug out roots are sun dried for 2-3 days and then dried under shade. The roots should be cut into pieces of 15-20 cm length and stored properly.

MUSHROOM

Mushrooms are good source of protein and mineral and low calories hence quite suitable for diabetic and heart patients. In fact, mushrooms are considered delicacies on dinning table. Like green plants sunlight is not required for successful mushroom cultivation, rather the mushroom beds should be protected from direct sunlight and rains. Therefore, they are grown indoor. A new comer can use any covered (bricked or thatched) accommodation, with proper ventilation as a mushroom house. Of the three widely cultivable varieties, oyster mushroom and tropical mushroom can be cultivated at relatively higher temperature in contrast to temperate or European or button mushroom.

1. Cultivation of Oyster Mushroom

There are many species of *Pleurotus* which can be grown on a wide range of substrates. But, under Haryana conditions *Pleurotus sajar-caju* and *P. florida* were found to be the best growing equally good on paddy/wheat and Brassica straw. They can be grown in the months of Feb. to April and then from Aug. to November without manipulating the temp. In these months, the indoor temp. ranges between 20 to 30° C which is optimum for this mushroom.

How to Grow

The straw to be used as substrate should not be old and exposed to rains. The paddy straw is chopped into small pieces of about 4-6 cm.

Chopped straw is soaked overnight (10-12 h) in clean water. Next day excess water is allowed to drain off by putting the straw on wire mesh for about an hour. The wet straw is mixed thoroughly with spawn (mushroom seed) 2-3%. This mixture is filled compactly in polythene bags (45 cm × 30 cm) in which holes (1 cm diameter each) 8 to 10 cm apart on both the sides have been made for proper aeration. The bag is filled upto the 3/4 of its capacity (2-3 kg straw) and mouth of the bag is tied with thread or rubber band or placed with upside down 20-30 cm apart. The bags are then placed in a well ventilated room.

The mycelium takes 12-15 days to permeate the substrate and makes it compact. When the mycelium has fully impregnated the substrate the polythene bags are cut open and removed gently without disturbing the straw block.

Crop

The relative humidity in cropping room is maintained between 70–85% by spraying water on the straw blocks, floor and even walls 1–2 times a day. The first crop can be had in 20–22 days after spawning and then two more flushes at an interval of 7–9 days. The mushroom should be picked by twisting and pulling gently before they start folding.

The fresh mushrooms are packed in perforated polythene bags (200 gm each) and marketed under the name 'Dhingri'. It can also be dried either in sun or mechanical dehydrator at 50 to 55°C.

2. Cultivation of Tropical or Paddy Straw Mushroom

This mushroom can be grown best on paddy straw, hence it is named as straw/paddy straw mushroom. It requires a high temperature i.e 30°C to 40°C for its vegetative as well as for reproductive phase. In Haryana it can be grown from April to September. It takes about 30–35 days for completing a crop cycle, thus a number of crop can be harvested during the season.

Paddy straw used should not be more than one year old, crumpled and should not contain any moulds and green leafy matter. The straw should preferably be hand thrashed.

The paddy straw is tied into small bundles each bundle weighing about a kilogram. These bundles are then steeped in clean water in a tank for 12-15 hours. The excess water is drained out for about an hour and beds are made on a raised bamboo frame.

Preparation of Beds

Forty-five bundles of soaked straw are required for making the standard bed of 1 m × 1 m size. Five bundles are placed side by side with all butt ends on one side say facing south, on a bamboo frame fixed on bricks. Another five bundles are placed on the top with butt ends on the opposite side, facing north. These ten bundles constitute the first layer. Bits of spawn are placed on the straw 10–12 cm from the border and 15 cm apart and then covered with powder of arhar/gram dal. A second layer of 10 straw bundles is laid on the top of first layer with butt and facing east and west. Again spawning is done in the same manner Likewise third and fourth layer is prepared and spawning in fourth layer is done not only along the edges but over the middle of the bed as well. This layer is covered with remaining five bundles of straw by placing them across and trampled slightly. Two bottles of spawn and 250 gms of arhar/gram dal powder is sufficient for one bed.

After Care and Harvesting

The beds should be watered daily, once or twice or sometimes even thrice also, to keep the beds moist, but not too wet. Mushrooms begin to appear 10–15 days after spawning and will continue to do so for 15–20 days producing 2–3 kg mushrooms per bed. The mushrooms should be picked before they open.

Sources of Availability of Spawn

Spawn of the two mushrooms can be had from the following sources :

1. Division of Mycology & Plant Pathology, I. A. R. I., New Delhi.
2. Department of Microbiology, P. A. U., Ludhiana.
3. Department of Plant Pathology, H. P. K. V. V., Chamba Ghat, Solan (H. P.)
4. National Centre for Mushroom Research and Training, Chamba-Ghat, Solan (H. P.).
5. Department of Plant Pathology, H. A. U., Hisar @ Rs. 6. per bottle (without bottle).

At all the above centres, the mushroom grower is supposed to place the order for spawn at least one month in advance.

Forestry is an important discipline for the uplift of the rural economy as well as for maintenance of environmental equilibria particularly at a time when fuel, fodder, packaging and pulping material, and timber are getting scarce. Due to intensive agriculture and destruction of original forest vegetation, the problems of salinity, alkalinity and wind and water erosion are ever increasing. A large tract of land in Haryana is lying waste. To cover the wastelands with vegetation and make best use of them for biomass production and to protect the arable lands, growing of trees either as plantations or integrated with agricultural crops as in agroforestry system is imperative. Growing of trees on the wastelands or along the agricultural crops, assures an additional income to the farmers while also reclaiming the wastelands and replenish soil fertility.

The nursery technology and planting techniques of important commercial species which are common with the farmers are given below :

POPLAR

Species Recommended	**Populus deltoides G.**
Type of Soil	(i) Alkali soil to be avoided.
	(ii) Deep and fertile soil is suitable.
	(iii) Needs irrigation in deep water table areas.
	(iv) Sandy soils need frequent irrigations.
	(v) Sandy soil with irrigation facility is the most suitable for growth.
Propagation	It is propagated by branch cuttings.
Time of Cuttings	January and February
Spacing in Nursery beds	60 × 30 cm

A. Nursery Techniques

In January-February, cuttings of 20-25 cm length are made from the branches and planted in the well prepared beds. While planting, two third portion of cutting is inserted in the soil with base of cutting put downward. After planting the cuttings and afterward frequent watering is done so that enough moisture stays in the bed. Regular cleaning of

weeds is done. After one year the plant sprouted out of the cutting would be ready for transplantation. The right method of planting the cutting is given in diagram below :

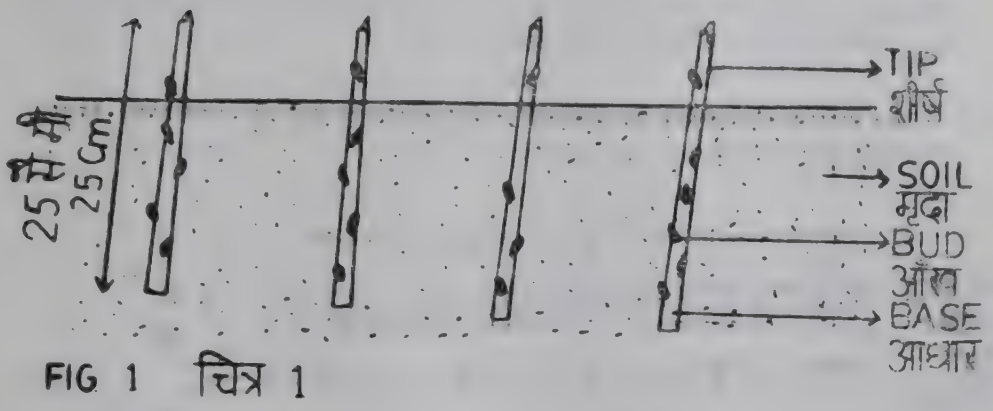


FIG 1 चित्र 1

Fertilisation : Adequate application of FYM in the nursery bed is essential if the soil is not fertile. After the rains have set 2.5 gm of urea per plant is given to maintain the growth.

Chemicals : At the time of planting cuttings, BHC 10% is added @ 20 gm/Sqm and also lower end of the cutting is dipped in Captan or Diathane powder to seal the cut against disease causing organisms.

B. Transplantation of sapling in the field

Time of Planting	January to February
Method	Naked root entire planting
Spacing	Generally poplar is planted in the fertile agricultural lands integrated with roots, rhizomes corms, forage and leafy vegetable crops. This is also integrated with horticultural crops as wind break on the borders. Poplar is also planted along the water channels :
(i) Along the crops (Mechanized agriculture can be done)	4×4 m

(ii) Along the water channels as single or double row — 1.5×1.5 m

(iii) Integrated with horticultural crops as alternate rows at a plant to plant spacing of 4 m or along the borders of the field. Pruning of poplar trees is essential in the system.

(iv) If the field exclusively for poplar then spacing can be reduced from 4×4 m to 3×3 m.

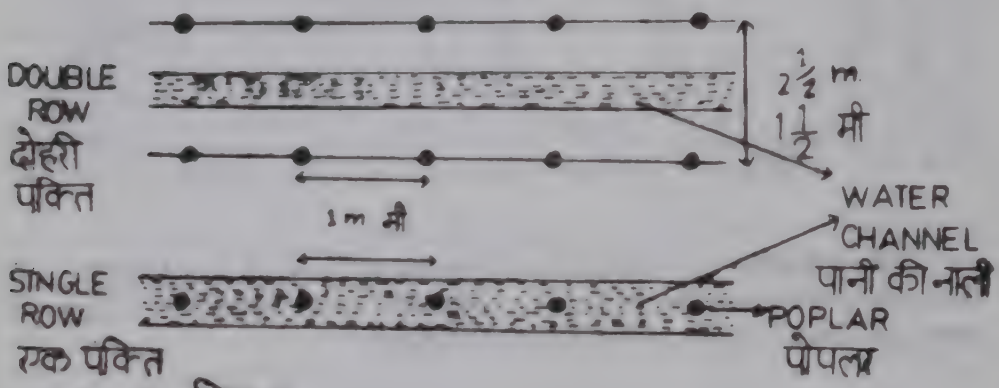


FIG. 2 चित्र 2

Size of Pits — 2×2 feet in cross section and 3 feet deep (60 cm×60 cm×90 cm)

White Ants Treatments — 10 gms of BHC (10%) mixed in the soil per pit.

Irrigation — Immediately after planting and then twice a month in the first year and then monthly in 2nd year and then only in dry periods as per needs.

Fertilization — Application of 100 gms of urea in two split doses during July and September alongwith irrigations every year.

Cultural Operations

1st Year

(i) Removal of buds which sprout on lower than 3 m of the stem.

(ii) Three weedings during April, July and September.

(iii) Unsprouted plants to be headed back flush to ground.

(iv) Gaps to be filled next year.

2nd Year — In January branches competing with leader needs removal and the interfering branches should be removed.

3rd Year — Similar operations are required in January.

4th Year — Two weedings during May and August and irrigations at 15-20 days interval during dry season.

Pruning

5th Year — In January all branches on lower one third length of stem should be removed.

6th Year — Branches on lower half of stem are pruned off.

8th Year — At 8 year age of plantation, branching of lower two third of stem should be removed.

Sale

There is no problem of the sale of standing poplar trees. WIMCO Limited engaged in match industry can even book the plantations in advance at their projected price. Other sport goods industries also come forward for the purchase of poplar trees. A tree with average 90 cm circumference can fetch about Rs. 500. Poplar is a good coppicer and produces second crop after felling. In such cases, cutting of the stem is done at a height of about 20 cm from the base.

Insect-pest Disease

Poplar is highly susceptible to stem borer. As soon as the disease becomes apparent on the stem in the form of sawdust coming out of the hole, a cotton plug

soaked with kerosene or petrol is inserted in the hole so that the insect inside is suffocated to death.

Stock Availability

Saplings of poplar are available from Forestry Department of H. A. U. at the cost of Re. 1/-per plant. Farmers themselves can raise their own nursery which is cheaper and most convenient.

EUCALYPTUS (SAFEDA)

There are large number of species suitable for different localities. But for Haryana, two species, namely, *Eucalyptus camaldulensis* and *Eucalyptus hybrid* are successful.

Planting Material

Nursery raised seedlings can be procured from H. A. U. Forestry Deptt. For large scale plantations nurseries can be raised by the growers themselves with short training from Forestry Department H. A. U., Hisar.

(i) Nursery Technique

The seeds are first sown in nursery beds and then picked out into polythene bags after germination. The nursery soil is worked thoroughly and raised beds (10 m × 1 m) are prepared. Sieved sand and FYM are added to the surface soil to improve the texture. 100 gm of 5% Aldrex is applied per bed for protection against insects and termites. 200 gm of seeds are sown per bed in 1 cm wide shallow furrows spaced 5 cm apart. The seeds are mixed with an equal quantity of fine sand before sowing. Sown furrows are given a light covering of sieved fine sand. Sowing is normally done in September-October after the monsoon rains. Sowing can also be done towards the end of winter season i. e. February & March. A thin layer of thatch grass is spread over the germination beds to hasten germination and to protect the seeds from washing away by rains or irrigation. The beds are kept watered by percolation through flood irrigation in the side channels or by sprayers fitted with atomiser nozzles. Germination of seed commences about 5 days after sowing when thatch cover is removed. Germination is completed in about 2-3 weeks and each bed yields about 12-15 thousand seedlings. For planting naked root plants the young seedlings are prickled out from the germination beds to the polythene bags which have to be watered and shifted till the seedlings get established; 50-60 cm high plants are used for the purpose of planting out in the fields.

(ii) **Transplantation in the field**

Time of Planting	(i) Most suitable time is during monsoon i. e. July-August. (ii) Where irrigation facilities are available planting can be done from Sept. to Feb. In such cases 3 to 4 good irrigations are needed at weekly intervals to establish plants.
Size of Pits	30 cm × 30 cm × 30 cm
Treatment of Pits	These pits should be filled with a mixure of top soil, and well-rotten farm yard manure in equal parts. The refilled pits should given irrigation before planting the trees. 10-15 gms of BHC 10% dust should be mixed in each pit before filling. In case of liquid preparations, insecticides can be applied alongwith the first irrigation.
Spacing	Along the bunds, channels, roads etc. 2 m apart. Agroforestry : 3 m × 2 m High density plantation : 2 m × 1 m

After Care

Where irrigation is available, safeda has to be irrigated twice a month. 2-3 weedings during first two years also help in better growth of plants.

Fertilization

In July planting, 20 gm of urea should be applied to every plant at the time of irrigation about one month after planting. The amount of fertilizer should be increased to 50 gm urea during second year and 100 gm urea during third to sixth year. In case of September-February planting first dose of fertilizer should be applied during next July.

Harvesting and Rotation

The rate of growth of safeda tree is generally on the increase upto 8th year. It should be harvested just after this age, say when the tree is

9 or 10 years old. In case of high density plantations the harvesting can be started in 4th year for fuelwood and fence posts.

Yield

Yield varies from place to place, species to species and depends on spacing, site, management practices, irrigation, fertilizations, etc. On an average the yield per tree comes to 0.5 cubic metre or 5 quintals which is about Rs. 400-500 per tree of about 10 years old at present market rate. On high density plantation one can start getting Rs. 15,000/- per year per ha after 3rd year if plantations are managed scientifically.

Marketing

There is some problem in marketing at present. Maximum price of wood is obtained if trees are felled and are disposed off in local markets by the farmers themselves. This gives 25-30% more return. Small poles of this tree are easily disposable in the local market.

Coppicing

Safeda is a good coppicer and once planted it can give three crops. Only one coppice shoot should be retained on each stool and gap, of any, should be filled up by planting new seedling. In localities where fuelwood and poles fetch good price, two coppice shoots can be retained per stool. Time of coppicing is important. Best time of coppice has been found to be November to February.

Uses

It can be used as fuelwood, industrial wood, transmission poles, fence posts, timber, and for making packing cases and furnitures.

COMPARISON BETWEEN POPLAR AND EUCALYPTUS

Poplar	Eucalyptus
(1) Nursery easy to grow and cheaper. Farmer can himself do this job.	(1) Nursery raising is a difficult job and costly also.
(2) Taller trees are available after one year old nursery.	(2) Short saplings are available after one year.
(3) Little care is needed while transplantation.	(3) Much care is needed.

(4) Poplar can be safely integrated with agricultural crops as its litter discharge and its subsequent decomposition is a quicker and also the species is deciduous.	(4) Species is evergreen and harms the crops growing underneath. Decomposition of its litter is a slow process.
(5) Does not draw heavily on moisture and nutrients of the soil.	(5) Draws heavily on soil water and nutrients.
(6) No allelopathic effect on other plants.	(6) Allelopathic effect is reported.
(7) Demand is increasing.	(7) Demand lesser than poplar.
(8) Higher price	(8) Low price

SUBABOOL

It has a wide range of applicability ranging from fuelwood to timber and other industrial uses like pulping. It is the chief source of protein for animal feed. It has many varieties which differ enormously in size and form. Three types are recognised.

Hawaiian Type	Short, bushy variety upto 5 m in height. It revegetates the denuded hill slopes, provides fire wood and charcoal. Yield of wood and fodder is low.
Salvador Type	Tall, tree-like-plant upto 20 m height. It is also known as arboreal or Guatemala types. Produces more than twice the biomass of Hawaiian type. Some extremely high yielding cultivars being the sources of timber, wood products and industrial fuel are known as "Hawaiian Giants" and designated as K 8, K 28, K 67.
Peru Type	Tall plants till 15 m height but with extensive branches even low down on the trunk. They produce little trunk, but extremely high quantities of foliage grown on their branches.

Species	*Leucaena leucocephala*
Varieties Recommended	
Farm and Agroforestry	Hawaiian giant, K 8, K 28, K 67
For fodder trees	Peru type
Grazing lands, pastures	Hawaiian type
Raising of nurseries	The plants are raised either in beds or in polythene bags by seed sowing.
Time of Sowing	February-March, July-August.
Treatment of Seed	(i) Soaking of seeds in warm water over night. (ii) Inoculation of seeds with Rhizobium culture. (iii) Seeds can also be treated with 65% sulphuric acid for 5 minutes and then dried for one hour in shade.
Sowing	Seeds can be sown directly in the field also. The polythene bags (22.5×12.5 cm) are filled with soil+FYM+sand in 1 : 1 : 1 proportion and the seeds are sown 1 cm deep. Regular watering with can is essential. In case of direct sowing in the field, monsoon is the best season and the seeds can be sown behind the plough in shallow furrows and levelled with Pata. The distance between the furrows can be kept 60 cm to 100 cm and 25-30 cm from seed to seed. In seed beds, the seeds are sown in sunken beds. Line to line distance is kept 15 cm to 20 cm and seed to seed 5-10 cm.
After Care	Regular watering, weeding and hoeing is essential.

Planting	Site preparation : The fields to be ploughed one or two times thoroughly removing all the weeds, grasses, etc.
Planting Distance	
(i) Along the Bunds Roads, Channels	2 m.
(ii) Agroforestry	In case of tractor ploughing the distance be kept 3 meter from line to line and 2 meter from plant to plant.
Energy plantation	2 m × 1 m is suggested.
High density plantation	1 m × 1 m (For first rotation) 2 m × 1 m (For second and third rotation through coppicing).
Time of Planting	Monsoon is the best season. In July-August when it is drizzling, the best success is achieved.
Pit Size	30 cm × 30 cm × 30 cm for tube plants and for naked root planting the depth be kept 45 cm. The old nursery stock can be used for stump planting too.
Treatment	In case of termites infestation, the mixing of 10 gm of BHC per pit is useful.
Fertilizer	In normal and good soils, the fertilizers are not needed. If soil is poor, the application of super phosphate 10-20 gm per pit is useful apart from FYM 5 kg/pit.
Irrigation	In dry season casual irrigation can be given. On average in one to two months one irrigation is essential. In case of agro-forestry, the irrigation for agriculture crop suffices.
Lopping	For the use of fodder and fuel, the plants can be lopped after 2 years of growth leaving the leading and thick branches.

All the twigs/branches upto thumb thickness and extra branches be cut by sharp prunning scissor or any other drat. The main tree grows for timber/fuelwood. The dwarf varieties are ready for cutting in the second year and the plants are cut above 75 cm from ground level at an interval of about 2 months.

Rotation

For industrial/fuel/timber use the trees can be felled after 8-10 years depending on the size of trees and biomass production. The crop is again ready from the stumps as the species is a good coppicer.

SPECIES FOR WASTELAND DEVELOPMENT

For wasteland development, the following species are recommended, which apart from improving the soil, also provides excellent fuel wood :

Highly tolerant to salinity

Tamarix articulata, Tamarix gallica, Casuarina cunninghamiana, Casuariana equisetfolia, Prosopis juliflora, Acacia nilotica, Acacia decurrens, Acacia catechu, Zizyphus jujuba, Zizyphus spinavulgaris, Butea monosperma, Ailanthus excelsa, Terminalia arjuna and *Capparis aphylla.*

Moderately tolerant

Acacia cyanophylla, Acacia decurrens, Parkinsonia aculeata, Eucalyptus camaldulensis, Eucalyptus citriodora, Eucalyptus tereticornis, Azadirachta indica, Albizzia lebbek, Dalbergia sissoo, Leucaena leucocephala. Bauhinia alva var. *candida* and *Pinus halepensis.*

For special forestry on common lands and also for energy plantations, the following species are useful :

Species for arid conditions

Prosopis cineraria (Jandi), *P. juliflora* (Jandi), *Acacia nilotica* (Desi Kikar), *A. auriculiformis* (Australian Kikar), *A. tortilis* (Tortalis Kikar), *A. albida* (African Kikar), *Parkinsonia aculeata* (Israel Kikar). *Tamarix indica* (Imli), *Albizzia lebbek* (Kala Siris), *Phyllanthus amblica* (Aonla), *Zizyphus mauritiana* (Ber), *Leucaena leucocephala* (Subabool), and *Morus alba* (Sahtoot).

Species for semi-arid conditions

Albizzia lebbek (Kala Siris), *A. stipulata* (Siris), *Dalbergia sissoo* (Shisham), *Cassia siamea, Populus deltoides* (Poplar), *Acacia nilotica* (Desi Kikar), *A. melanoxylon, Prosopis cineraria* (Khejri), *Pithecellobium dulce, Eucalyptus citriodora* (Eucalyptus), *E. camaldulensis* (Eucalyptus), *Melia azadirachta* (Neem) and *Cordia myxa* (Lasura).

Species for mesic conditions

Anogeissus latifolia (Anogessus), *Ailanthus excelsa* (Ailanthus), *Bauhinia variegata* (Kachnar), *Albizzia lebbek* (Kala Siris), *Leucaena leucocephala* (Subabool), *Populus deltoides* (Poplar), *Bombax malabaricum* (Simbal), *Eucalyptus hybrid* (Eucalyptus), *E. globulus* (Eucalyptus), *Celtis australis* (Celtis) and *Grewia optiva.*

DIRECTORATE OF EXTENSION EDUCATION

ECONOMICS OF IMPORTANT KHARIF CROPS IN HARYANA DURING 1996

The present study was conducted by District Extension Specialists (F. M.), under the supervision and guidance of Sr. Extension Specialist (F.M.) to find out the costs and returns of important kharif crops grown in 1996 in the district of their posting so that the information can be used by farmers, administrators and policy makers in taking appropriate decisions about allocation of agricultural resources. Each district was stratified in the crop zones on the basis of existing oropping pattern. One village from each crop zone was selected randomly. The land holdings of the concerned districts are classified into small, medium and large farm size groups using 1990-91 land census figures. Accordingly the holdings of the selected villages were divided into these farm size groups and a sample of approximately 40 farmers were selected randomly from the selected villages of a district in proportion to the frequency of farmers falling in these farm size groups.

All the crops included in the economic analysis are not necessarily grown by all the selected farmers. Considerable variations in the costs and returns have been observed among farmers and districts on account of differences in agro-climatic conditions, soil types, resource use pattern, farming practices followed etc. Thus the results presented in the tables gives only an average picture of diverse districts for the state.

For obtaining estimates of costs of cultivation/production of crops, the opportunity cost of owned inputs and actual prices paid by the farmers for purchased inputs were taken into account. Charges for irrigation, labour, machinery and rental value of land were considered at the prevailing market rates of the locality. Interest on working capital was computed @ of 12 per cent per annum for the period the crop remained in the field. Transportation cost includes the expenditure involved in the transportation of crop produce from farm to the threshing floor, farm house and to the market. Total cost also includes management charges and risk allowances, each of which are indirectly estimated @ 10 per cent of the total cost. The returns from the farm produce were estimated at post harvest wholesale prices of the produce. Cost of production per quintal without by product is computed by dividing the total cost by the yield of the main product. Cost of pro-

duction with by product is worked out by deducting the estimated cost of producing the by product which is indirectly worked out by assuming its same share in the cost as its share in the gross returns. The reduced cost is then divided by the main product.

Note : 1. Figures in the parantheses show the share of the item in the total cost per acre.

2. State average of each item is computed as the weighted average using the total area under the crop in the sample as the weight.

INPUT-OUTPUT PRICES FOR KHARIF CROPS 1996

A. Seed & Seedlings (Rs/acre/kg)

1.	Dwarf fine paddy seedlings/acre	=	180
2.	Dwarf coarse paddy seedlings/acre	=	207
3.	Basmati paddy seedlings/acre	=	266
4.	Hybrid bajra Rs./kg	=	31
5.	Jowar Rs./kg	=	7.50
6.	American cotton Rs /kg	=	24
7.	Desi cotton Rs./kg	=	22.50
8.	Guar Rs./kg	=	8.50

B. Fertilizer (Rs./qtl.)

1.	Urea (46%)	=	332
2.	DAP	=	980
3.	SSP	=	280
4.	Zinc sulphate	=	987
5.	F. Y. M.	=	8

C. Insecticides/Pesticides (Rs./litre/kg)

1.	Endo sulphan	=	165.00
2.	Monocrotophos	=	240.50
3.	Butachlor	=	143.50
4.	Cyfermethins 20%	=	493.50
5.	Fenvelerate dust	=	86.50
6.	Isoproton	=	245.00
7.	Chlorbyriphos	=	223.80

D. Hiring Rates (Rs./acre/day)

1.	Human labour	=	50–60
2.	Bullock	=	90–100
3.	Tractor ploughing/acre	=	90–100
4.	Tubewell including labour		
	(a) Electric (Rs./acre)	=	100–140
	(b) Diesel (Rs./acre)	=	125–150

OUT-PUT PRICES

A. Main Product (Rs./qtl.)

1.	Paddy dwarf fine	= 420
2.	Paddy dwarf coarse	= 395
3.	Paddy basmati	= 1108
4.	Bajra	= 383
5.	Green Jower	= 37.42
6.	Ame. Cotton	= 1573
7.	Desi Cotton	= 1155

B. By-products (Rs./acre)

1.	Dwarf fine paddy straw	= 128
2.	Dwarf coarse paddy straw	= 149
3.	Basmati paddy straw	= 347
4.	Ame. Cotton sticks	= 187
5.	Desi Cotton sticks	= 131
6.	Bajra Karbi (Rs./qtl.)	= 65.20

Sr. No.	Item	Paddy (Dwarf-fine)			Paddy (Dwarf-coarse)			Paddy (Basmati)			Cotton (Am.)			Cotton (Desi)		
		Qty.	Val.		Qty.	Val.		Qty.	Val.		Qty.	Val.		Qty.	Val.	
1	2	3			4			5			6			7		
1.	Preparatory tillage	5.7	574	(6.47)	5.6	583	(6.49)	5.8	590	(6.99)	3.8	403	(5.30)	3.6	374	(5.14)
2.	Pre-sowing irrigation		86	(0.97)		98	(1.09)		112	(1.33)		103	(1.35)		99	(1.36)
3.	Sowing		297	(3.34)		300	(3.34)		329	(3.90)		80	(1.05)		83	(1.14)
4.	Ridging		30	(0.34)		22	(0.25)		30	(0.36)		28	(0.37)		28	(0.38)
5.	Seed (kg)	6.8	180	(2.03)	5.7	207	(2.31)	6.0	266	(3.15)	5.2	126	(1.66)	4.1	92	(1.26)
6.	Seed treatment		2	(0.02)		6	(0.07)		2	(0.02)		11	(0.14)		—	
7.	FYM (qtl.)	3.5	27	(0.30)	13.4	107	(1.19)	3.4	26	(0.31)	5.8	40	(0.53)	4.8	28	(0.38)
8.	Fertilizer Nutrients															
	a) Nitrogen	59.4	392	(4.42)	56.3	406	(4.52)	29.5	213	(2.52)	33.8	243	(3.20)	32.9	237	(3.25)
	b) Phosphatic	16.2	327	(3.68)	18.1	334	(3.72)	13.4	248	(2.94)	11.6	215	(2.83)	12.0	222	(3.05)
	c) Potassic	1.3	9	(0.10)	4.6	34	(0.38)		—			—			—	
	d) Zinc Sulphate	7.5	74	(0.83)	7.9	78	(0.87)	5.9	58	(0.69)		—		0.5	5	(0.07)
	Total Fert. Invest.		802	(9.03)		852	(9.49)		519	(6.15)		458	(6.03)		464	(6.37)
9.	Fert. Application		30	(0.34)		19	(0.21)		20	(0.24)		33	(0.43)		22	(0.30)
10.	Irrigation	12.2	1107	(12.47)	11.5	1015	(11.30)	9.4	879	(10.41)	3.8	373	(4.91)	2.4	253	(3.48)
11.	Hoeing/weeding															
	a) Chemical		148	(1.67)		142	(1.58)		141	(1.67)		—			—	
	b) Manual		47	(0.53)		19	(0.21)		42	(0.50)		417	(5,48)		295	(4.05)
12.	Plant protection		166	(1.87)		123	(1.37)		118	(1.40)		950	(12.50)		769	(10.56)

13.	Harvesting	493	(5.55)	461	(5.13)	638	(7.56)	677	(8.90)	806	(11.07)
14.	Threshing/winnowing	—		—		—		—		—	
15.	Miscellaneous	38	(0.43)	32	(0.36)	37	(0.44)	56	(0.74)	66	(0.91)
16.	Interest on working capital	207	(2.33)	204	(2.27)	190	(2.25)	201	(2.64)	180	(2.47)
17.	Variable cost	3660	(41.24)	3607	(40.17)	3349	(39.68)	3553	(46.73)	3185	(43.75)
18.	Management charges	740	(8.34)	748	(8.33)	703	(8.33)	634	(8.34)	607	(8.34)
19.	Risk factor	740	(8.34)	748	(8.33)	703	(8.33)	634	(8.34)	607	(8.34)
20.	Transportation charges	156	(1.76)	75	(0.84)	91	(1.08)	56	(0.74)	53	(0.73)
21.	Rental Value of land	3005	(33.86)	3218	(35.84)	3003	(35.58)	2323	(30.55)	2454	(33.71)
22.	Total cost	8875	(100.00)	8979	(100.00)	8439	(100.00)	7603	(100.00)	7280	(100.00)
23.	Production (qtl.)										
	a) Main	22.2	9323	23.1	9125	8.6	9528	4.28	6733	6.25	7217
	b) By product		128		149		347		187		131
24.	Gross return		9451		9274		9875		6968		7348
25.	Return over variable cost		5790		5667		6526		3415		4163
26.	Net return		576		295		1436		635		68
27.	Cost of production/ qtl.										
	a) Without by-product		400		389		981		1776		1165
	b) With by-product		394		382		947		1729		1144

1	2	3	4	5	6	7
28.	Number of farmers	137	26	73	82	40
29.	Area (acre)	989.5	201.5	312	522	132
30.	Labour					
	a) Human days	32.4	29	32.6	39.2	36.8
	b) Bullock days	0.3	1	0.1	2.6	1.8
	c) Tractor hours	6.1	5.5	6.2	5.1	6.2

Sr. No.	Item	Bajra (Hybrid) Qty.	Val.		Jowar Qty.	Val.		Guar Qty.	Val.	
1	2	3			4			5		
1.	Preparatory tillage	3.0	297	(7.12)	3.5	382	(7.20)	1.96	200	(10.06)
2.	Pre-sowing irrigation		12	(0.29)		86	(1.62)		1	(0.05)
3.	Sowing		100	(2.40)		125	(2.35)		84	(4.22)
4.	Ridging		16	(0.38)		34	(0.64)		9	(0.45)
5.	Seed (kg)	1.8	56	(1.34)	19.7	148	(2.79)	8.5	71	(3.57)
6.	Seed treatment		2	(0.05)		—			—	
7.	FYM (qtl.)	4.2	34	(0.81)	2.0	16	(0.30)		—	
8.	Fertilizer Nutrients									
	(a) Nitrogen	16.5	118	(2.83)	20.6	149	(2.81)		—	
	(b) Phosphatic	2.3	42	(1.01)	5.6	106	(2.00)		—	
	(c) Potassic		—			—			—	
	(d) Zinc Sulphate		—			—			—	
	Total Fert. Invest.		160	(3.84)		255	(4.81)		—	
9.	Fert. Application		14	(0.34)		11	(0.21)		—	
10.	Irrigation	0.4	36	(0.86)	2.3	237	(4.47)	0.08	8	(0.40)

1	2	3		4		5	
11.	Hoeing/weeding						
	(a) Chemical	—		—		—	
	(b) Manual	183	(4.39)	—		16	(0.80)
12.	Plant protection	24	(0.58)	—		54	(2.71)
13.	Harvesting	446	(10.69)	524	(9.87)	209	(10.51)
14.	Threshing/winnowing	232	(5.56)	—		154	(7.74)
15.	Miscellaneous	49	(1.17)	59	(1.11)	17	(0.85)
16.	Interest on working capital	82	(1.97)	90	(1.70)	37	(1.86)
17.	Variable cost	1446	(34.66)	1585	(29.87)	660	(33.18)
18.	Management charges	348	(8.34)	442	(8.33)	166	(8.35)
19.	Risk factor	348	(8.34)	442	(8.33)	166	(8.35)
20.	Transportation charges	92	(2.20)	573	(10.80)	58	(2.92)
21.	Rental value of land	1641	(39.33)	1882	(35.47)	739	(37.15)
22.	Total cost	4172	(100.00)	5306	(100.00)	1989	(100.00)
23.	Production (qtl.)						
	(a) Main	4.44	1702	175	6549	2.08	2118
	(b) By-product	11.5	750		—	3.20	268

24.	Gross return	2452		6549		2386
25.	Return over variable cost	1006		4964		1726
26.	Net return	−1720		1243		397
27.	Cost of production/qtl.					
	(a) Without by-product	940		30		956
	(b) With by-product	652		—		849
28.	Number of farmers	124		147		25
29.	Area (acre)	436.3		274.7		93
30.	Labour					
	(a) Human days	17.6		15.6		12.6
	(b) Bullock days	1.8		0.3		1.2
	(c) Tractor hours	3.3		4.5		3.4

SUMMARY AND CONCLUSION

A. Paddy

1. It is the main kharif crop of eastern zone accounting for over 83 per cent of area and 81 per cent of paddy output in the State. Slowly but steadily the area under basmati is gaining importance. Dwarf paddy area is mainly under fine varieties.

2. The annual compound growth rates during the last 30 years from 1966-67 through 1995-96 in respect of area, yield and production were 4.48, 2.45 and 7.04 per cent, respectively as against 7.38, 2.99 and 10.59 per cents in western zone and 4.87, 2.56 and 7.53 per cents in the State as a whole.

3. The average per acre yield of dwarf coarse (23.1 qtl.), dwarf fine (22.2 qtl.) and Basmati paddy (8.6 qtl.) not only covered the total cost of cultivation but also provided a net profit of Rs. 295, Rs. 576 and Rs. 1436, respectively in the State.

4. Per quintal cost of production of paddy with by-product being Rs. 394, Rs. 382 and Rs. 947 for dwarf fine, dwarf coarse and Basmati paddy were lower than their respective realised price of Rs. 420, Rs. 395 and Rs. 1108 leaving a profit margin of Rs. 26, Rs. 13 and Rs. 161 per quintal of paddy, respectively.

5. The productivity and profitability of paddy of all types can be improved further by adopting seed treatment before nursery sowing to get disease free healthy seedlings, increasing population to optimum and making balanced use of fertilizers.

B. Cotton

1. Cotton is the main cash crop of kharif season of western zone accounting for 97 per cent of the area and 98 per cent of cotton production in the State. American cotton accounts for 75 per cent of area and 75.2 per cent of cotton production in the State. The area, yield and production of American cotton in the State increased at the annual compound growth rate of 6.74, 0.84 and 7.90 per cent, respectively as compared to 7.15, 0.75 and 8.22 per cent in Western Zone during the period 1966-67 through 1995-96. The area, yield and production of desi cotton virtually stagnated/slightly declined during this period.

2. American cotton this year was damaged by white fly, curl virus and heliothis insect resulting in decline in yield which was accompanied by decline in its realised price during post harvest period. Therefore American Cotton growers suffered a loss of Rs. 635 per acre instead

of earning the usual profit margin. Desi cotton was relatively free from insect pest and disease problems. Therefore growers of desi cotton earned a small net profit of Rs. 68 per acre.

3. Our University has introduced an hybrid variety of American cotton which coupled with integrated pest management is expected to enhance the yield and profitability of American Cotton further.

C. **Bajra**

1. Bajra is the main crop of kharif season in dry farming areas of western zone in particular. The zone accounts for nearly 77 per cent of the area and three-fourth of bajra production in the State. This crop is mainly confined to marginal land in rainfed areas. Therefore, its area, yield and production fluctuates considerably and stagnated at the annual growth rate of —1.58, 2.08 and 0.62 per cent, respectively during the period 1966-67 through 1995-96. The small positive growth rates in yield and production were only due to increasing coverage of bajra area under hybrid varieties.

2. Being almost a rainfed crop, the adoption level of yield increasing inputs is low resulting in low productivity economic status and negative returns of the crops.

3. The average yield of 4.44 qtl. of grain and 11.5 qtl. of dry fodder could not cover the total cost of cultivation of bajra. Eventually Bajra growers suffered an average loss of Rs. 1720 per acre. The crop is grown mainly to meet fodder requirements of the livestock by the farmers. Unless efforts are made to increase crop productivity through the adoption of improved package of practices, its grain productivity and relative profitability of the crop will continue to stagnate.

D. **Jowar (Green)**

1. Jowar provides green and dry fodder for the livestock Eastern Zone accounts for more than 90 per cent of the area and production of jowar fodder. Inspite of increase in the population of livestock in the State the area under jowar has been declining at the annual compund growth rate of 2.08 per cent during the period 1966-67 through 1995-96.

2. The average yield of 175 quintals of green fodder per acre not only covered the total cost of cultivation of jowar but also provided a net margin of Rs. 1243 per acre.

Not only productivity of green fodder need to be increased by using improved seed of multi-cut varieties and balanced dozes of fertilizers but also the decline in jowar area need to be arrested immediately. All efforts need to be made to meet the acute shortage of green fodder which remain phosphorous deficient due to non use of phosphate fertilizers in the crop.

E. Guar

1. Being fairly tolerant to drought, it is a valuable fodder, animal feed, vegetable and soil enriching crop of rainfed areas. Due to the presence of gum in its endosperm, guar has assumed industrial importance too.

2. Being a rainfed crop grown on marginal land, farmers hardly adopt the prescribed package of practices to increase the crop productivity.

3. Even low yield of 2.08 quintals of guar per acre provided a net profit of Rs. 397. Thus guar can gain area at the expense of bajra under rainfed condition.

APPENDIX I

Reclamation of Salt Affected Soils

From reclamation point of view salt affected soils of Haryana may be broadly classified as *saline soils or sodic soils.*

The 'Saline soils' have excess of soluble salts (>0.1%, ECe>4 mmhos/cm) with calcium, magnesium, sodium chloride and sulphate as major ions. Such soils can be reclaimed and profitably utilized by leaching and following suitable crop rotations and management practices.

'Sodic/Alkali' soils have sodium carbonate as a major component of soluble salts. Such soils have high pH (>9) and high exchangeable sodium percentage (>50). These soils can be reclaimed by leaching followed by application of gypsum, suitable crop rotations and management practices.

Reclamation of Saline Soils

1. Divide your fields into plot size of about 1/20th of a hectare.
2. Prepare strong bunds of about 30 cm height around each plot.
3. Level these plots as meticulously as possible.
4. Add 30 cm of water in two splits. This will reduce the salt content of surface 30 cm soil layer to less than 10 per cent of its original value.
5. To start with, grow tolerant to semi-tolerant crops like rice, cotton, wheat, barley, etc.
6. Keep these soils under intensive cropping to maintain downward flow of water just to avoid resalinization.
7. Leaching and irrigation of these soils should be done invariably with underground water if its quality is good and water table is within 2 meters.
8. In case of highly saline soils (i. e., ECe>50 mmhos/cm) having shallow water table (within 2 meters), leaching should invariably be done with underground water provided its EC is <8000μ (mmhos/cm). For using such waters for subsequent irrigations, instructions as given in section "Use of saline waters" should be followed.

Reclamation of Saline Sodic Soils

1. Divide the field into plot size of 1/20th of a hectare.

2. Prepare strong bunds of about 30 cm height around each plot.

3. Level the individual plots as meticulously as possible.

4. Leach the plot with 30 cm of fresh water to remove excessive soluble carbonates. This enhances the efficiency of applied gypsum.

5. When the field comes into *Watter* condition apply powdered gypsum (30 mesh) @ 50% of gypsum requirement for 0-15 cm soil layer. The gypsum should be spread uniformly. To know the gypsum requirement the soil should be got tested from soil testing laboratories.

6. After applying gypsum on the surface, the soil should be ploughed upto 10 cm depth. Deep mixing of gypsum reduces its efficiency.

7. Give 15 cm deep irrigation with fresh water in the gypsum treated plots.

8. For better stand, 3 to 4 seedlings of paddy *per hill* (about 30 days old) should be transplanted. The seedling should not be planted deeper than 2-3 cm in the soil.

9. About one week after green manuring, paddy should be transplanted in the field. Nitrogen, P_2O_5 and K_2O should be applied @ 150, 60 and 60 kg/ha, respectively. Zinc sulphate should be applied @ 45 kg/ha. P and Zn should be applied before transplanting, while N should be given in splits.

10. Where irrigation facilities don't permit paddy sowing, *dhaincha*, may be sown with the start of monsoon and either green manured in September or kept for seed. After *dhaincha*, barley or wheat can be sown.

11. The above treatments except the application of gypsum should be repeated next year.

12. After paddy, wheat, barley, sugarbeet, senji or *berseem* can be sown in the field.

Recommendation for the use of sodic (RSC>2.5) waters

1. Sodic water having RSC upto 12 me/l and EC<4 dS/m could be used on light textured soils with the application of gypsum for crops like wheat, barley, mustard, oats, bajra, guar and sorghum.

2. Kharif crop should be sown with a Ridger Seeder, else crops will die due to standing of excessive water.

3. If kharif crop is to be taken then add gypsum @ of half the recommended dose. Take crop only after a good rain or heavy irrigation.

4. If the field is to fallow during kharif than add full dose of gypsum at the onset of monsoon.

5. Add gypsum before the presowing irrigation of rabi crop but on the basis of water requirement.

6. Spend on gypsum instead of FYM, as the addition of gypsum improve these fields and not the FYM.

7. One or two deep ploughing should be done in these fields, as this will check the flow of water from the fields and help in leaching of salts.

APPENDIX II

Efficient Use of Underground Waters in Haryana

On an average 37 percent of the underground waters in the state are of good quality, 8% normal, 18% sodic and 26% saline sodic. Efficient and economic utilization of each group of water in relation to soil, crop, climate and management practices is also detailed in a tabulated form below :

चित्र 1

On the basis of legend of the map

(a) **Good Waters**

EC × 10^6 < 2.0 dS/m
SAR < 10
RSC < 2.5 (me/l)

(b) **Noral Waters**

EC × 10^6 < 2.0-4.0 dS/m
SAR < 10
RSC < 2.5 (me/l)

(c) **Sodic Waters**

EC × 10^6 < 4.0 dS/m
SAR > 10
RSC < ⩾ 2.5 (me/l)

(d) **Saline Waters**

EC × 10^6 < 4.0 dS/m
SAR < 10
RSC < Nil (me/l)

(e) **Saline sodic Waters**

EC × 10^6 > 4.0 dS/m
SAR > 10
RSC < > 2.5 (me/l)

Guide lines for the use of saline/sodic waters western parts of Haryana

EC_{iw} (dS/m)	Soil type	Salt tolerance of crops	Minimum annual rainfall (mm)	Management practices to be adopted
1. *Low salinity waters*				
(i) EC ⩽.75	All soil types	Semi-tolerant	250	Common package of practices
(ii) EC=2.0	-do-	Tolerant	-do-	-do-
2. *Medium salinity waters*				
(i) EC=2.0	Loams	Semi-tolerant	-do-	-do-
(ii) EC=4.0	-do-	Tolerant	-do-	Mix with canal water or use it alternatively with canal water.
3. *Medium to high salinity waters*				
(i) EC=4.0	Sandy loams	Semi-tolerant	350	Common package of practices
(ii) EC=6.0	-do-	Tolerant	-do-	-do-
(iii) EC=6.0	-do-	Semi-tolerant	-do-	(i) Pre-sowing irrigation with canal water (ii) Kharif fallow

(iv) EC=8.0	-do-	Tolerant	-do-	(i) Pre-sowing irrigation with canal water (ii) Kharif fallow
4. *High to very high salinity waters*				
(i) EC=8—12	Loamy sands	Tolerant rabi only	400	(i) Kharif fallow
(ii) EC_{iw}=12—16 Sands and loamy sand		Tolerant rabi crops only		(ii) Addition of FYM @ 25 to 30 t/ha (ii) Sowing on conserved moisture or heavy pre sowing irrigation with tubewell water in the absence of canal water. (iv) Dry sowing of seeds followed by quick irrigation with tubewell water. (v) Increased seed rate by 20%.

Note :

1. These recommendations are applicable only for condition with water table deeper than 2 m. There is no hard pan and soils are well drained. Otherwise the EC_{iw} limit will that of heavy soils.
2. SO_4–dominated (70% or more) saline waters are less harmful than the Cl-dominated waters.
3. If the Cl : SO_4 is >2 and soils are deficient or medium in phosphorus than add Phosphorus 25 to 50% than the recommendation preferably through super phosphate.

4. If the waters are rich in nitrogen and potassium than add less of these nutrients. If water contain 1.0 me/1 of nitrate and/or potassium than these water add 4.0 and 11.5 kg/acre of nitrogen and potassium, respectively per irrigation of 7.5 cm.

5. (i) Salt tolerant crops : barley, wheat, mustard, sunflower, spinach, pearlmillet, cotton, ber and phalsa.

   (ii) Semi tolerant crops : Barseem, guar, pea, bakla, tobacco, cauliflower, pomegranate, guava.

   (iii) Sensitive crops : Pulses, gram, groundnut, rice, citrus, mango, papaya etc.

6. Annual Average rainfall (mm)

   (i) Less than 300 mm : Siwani, Sirsa.

   (ii) 300 to 400 mm : Salhawas, Beri, Tohana, Hansi, Fatehabad, Hisar, Loharu, Bhiwani, Khol and Farakh Nagar.

   (iii) 400 to 500 mm : Kaithal, Guhla, Rajaund, Jautsana, Punhana, Taoru and Bawal.

   (iv) More than 500 mm : Jind, Sonepat, Gohana, Jhajjar, Pataudi, Mahendragarh, Narnaul, Dadri, Rewari, Hathin, Hassanpur, Sohna, Nuh, Palwal, Ferozpur Jhirka, Ballabgarh and Gurgaon.

Western parts of Haryana

Suggestions for the use of saline or sodic waters (Average annual rainfall <500 mm, EC <4.) dS/m, SAR>10 and RSC >2.5 me/1)

1. EC_{iw} <4 ds/m	i. Use only in rabi for salt tolerant/semi tolerant crops like wheat, barley and mustard in sandy, loamy sand, sandy loam and loam soils.
	ii. Do not use for crops which require heavy irrigation like barseem, sugarcane and paddy.
	iii. Neutralize RSC by adding gypsum (75% pure). For neutralization of 1 me/1 of RSC the gypsum requirement is 30 kg/acre per irrigation of 7.5 cm.
	iv. After the harvest of rabi and before the onset of monsoon add powdered gypsum on the surface of soil on the basis of gypsum requirement and mix. Take bajra/guar either with rain water or good quality water. In emergency condition use water having EC less than 2 dS/m once or twice for bajra, guar and cotton.
	v. Use water of EC 1 dS/m for paddy once or twice under emergency conditions.

Note : Give special attention to the following suggestions :

1. Normally use 20 to 25% more nitrogenous fertilizers. If tubewell water contain nitrate than 100 me/1 nitrate will add 4 kg nitrogen/acre for every irrigation of 7.5 cm.
2. If the soil has become barren by the constant use of sodic water than get it analysed and add gypsum according to the recommendation. After ward use gypsum only on the basis of water every year.
3. For water having nil RSC but SAR >15 add some gypsum this will absorb the standing water. This way successful guar, bajra and cotton crop can be raised.
4. Use saline sodic water (EC <8 dS/m SAR >10) could be used for salt tolerant crops like wheat, barley, mustard for rabi only, on light textured soils and if gypsum is added as suggested above.

Guidelines for the use of saline/sodic waters in eastern parts of Haryana
(Annual Average rainfall > 500 mm)
(SAR < 10)

	EC_{iw} (dS/m)	Soil Type	Salt Tolerance of crops	Management Practices to be adopted
1.	Less Saline waters EC_{iw} < 2.0	All soil Types	All crops	Common package of practices
2.	Medium salinity waters			
	(i) EC_{iw} = 2.0	Sandy to loamy soils	-Do-	Salt tolerant crops. Mix with canal water or use it alternately with canal water
	(ii) EC_{iw} = 2-4	-Do-	Semi Tolerant	(i) Common package of practices (ii) Clay loam and clay soils with pre sowing irrigation with canal waters and after ward with canal water or alternately with canal water.
3.	Medium to high salinity waters			
	(i) EC_{iw} = 4	Sandy, loamy sand sandy loam	Semi tolerant, and tolerant	In loam soil pre sowing irrigation with canal water
	(ii) EC_{iw} = 6	-Do-	Tolerant	(i) Pre sowing irrigation with canal water (ii) Loam soil mix with canal water
	(iii) EC_{iw} = 6	-Do-	Semi tolerant	(i) Pre sowing irrigation with canal or good water

			(ii) Mix with canal water or use it alternately with canal water
(iv) EC_{iw}=8	-Do-	Tolerant	-Do-
4. High to very high salinity waters			
(i) EC_{iw}=8-12	Sandy and loamy sand	Tolerant rabi crops only	(i) Kharif fallow or only rain fed crops.
			(ii) In sandy loam soils pre sowing irrigation with canal water
			(iii) Mix with canal water or use very less water
			(iv) Apply 6-8 t/acre/annual of FYM
			(v) If only tubewell water, pre sowing with 10 cm of canal water or on rain water.
			(vi) Dry sowing and irrigation within 2-3 days.
			(vii) 20% more seed

Note :

1. These recommendations are applicable only for condition with water table deeper than 2 m. There is no hard pan and soils are well drained. Otherwise the EC_{iw} limit will that of heavy soils.

2. SO_4-dominated (70% or more) saline waters are less harmful than the Cl-dominated waters.

3. If the Cl : SO_4 is >2 and soils are deficient or medium in phosphorus than add Phosphorus 25 to 50% than the recommendation preferably through super phosphate.

4. If the waters are rich in nitrogen and potassium than add less of these nutrients. If water contain 1.0 me/l of nitrate and/or potassium than these water add 4.0 and 11.5 kg/acre of nitrogen and potassium, respectively per irrigation of 7.5 cm.

5. (i) Salt tolerant crops : barley, wheat, mustard, sunflower, spinach, pearlmillet, cotton, ber and phalsa.
   (ii) Semi tolerant crops : Barseem, guar, pea, bakla, tobacco, cauliflower, pomegranate, guava.
   (iii) Sensitive crops : Pulses, gram, groundnut, rice, citrus, mango, papaya etc.

6. Annual Average rainfall (mm)
   (i) Less than 500-600 mm : Jind, Sonepat, Gohana, Jhajjar, Rohtak, Pataudi, Mahendragarh, Narnaul, Dadri, Rewari, Hathin, Hassanpur, Sohna, Nuh
   (ii) 600 to 700 mm : Thanesar, Panipat, Baalbgarh, Palwal, Ferozpur Jhirka
   (iii) More than 700 mm : Chandigarh, Ambala, Jagadhari, Kalka, Naraingarh, Karnal, Gurgaon

Guidelines for the use of sodic waters in eastern parts of Haryana
(Annual Average rainfall > 500 mm)
(EC < 4 dS/m, SAR > 10 and RSC > 2.5 me/l)

		Management practices to be adopted
1.	$EC_{tw} < 4$	(i) Only for rabi in tolerant, semi tolerant crops like barly, wheat, mustard for sandy, loamy sand, sandy loam and loam soils.
		(ii) Do not use such waters for crops requiring high amount of water like Barseem, sugarcane and paddy.
		(iii) Neutralize RSC by adding gypsum (75% pure). For neutralization of 1 me/l of RSC the gypsum requirement is 30 kg/acre per irrigation of 7.5 cm.
		(iv) After the harvest of rabi and before the onset of monsoon add powdered gypsum on the surface of soil on the basis of gypsum requirement and mix. Take bajra/guar either with rain water or good quality water. In emergency condition use water having EC less than 2 dS/m once or twice for bajra, guar and cotton.
		(v) Use water of EC 1 dS/m for paddy once or twice under emergency conditions.

Note :

1. Give special attention to the following suggestions.
2. Normally use 20 to 25% more nitrogenous fertilizers. If tubewell water contain nitrate than 100 me/l nitrate will add 4 kg nitrogen/acre for every irrigation of 7.5 cm.

3. If the soil has become barren by the constant use sodic water than get it analysed and add gypsum according to the recommendation. After ward use gypsum only on the basis of water every year.

4. For water having nil RSC but SAR>15 add some gypsum this will absorb the standing water. This way successful guar, bajra and cotton crop can be raised.

5. Use saline sodic water (EC<8 dS/m SAR>10) could be used for salt tolerant crops like wheat, barley, mustard for rabi only, on light textured soils and if gypsum is added as suggested above.

APPENDIX III

Recommendations on Soil & Water Management
(Agricultural Engineering Aspect)

Lining of Water Courses

Lining of field irrigation channels (water courses) with durable, effective and yet cheap materials especially in light and medium textured soils can save 20-30 per cent irrigation water loss occurring as seepage besides several other benefits in comparison to unlined channels. The farm irrigation channels may be lined with following materials and method for the best results :

(i) **With Bricks and Cement Sand** : First class bricks thoroughly soaked in water are laid flat on well compacted sub-grade as well as on sides and joints are filled with 1 : 4 cement-sand and inside surface plastered to 1 cm thickness using 1 : 4 cement : sand. The bed can also be laid with 3.75 cm thick well mixed concrete (1 : 3 : 5) (Cement : Sand : Gravel) on 3.75 cm well compacted brick ballast or slate kattals.

(ii) **Concrete Lining** : It may be placed in forms as precast or placed at site to the bed and sides. A mixture of 1 : 3 : 5 (Cement : Sand and Bajri or Stone ballast of 1-3 cm size), gives a strong and durable lining. A water cement ratio of 25 litres water per bag of cement has been found to give good results. Lining should not be less than 3.5 cm thick. Transverse contraction joints to control cracking must be provided every 2-3 metres. These joints are formed by making vertical groves on the top 1/3 thickness of concrete. The grove is made of flat steel piece 0.5 cm thick and filled with suitable sealing compound like bitumen or asphatic compounds. When sleeper side slopes or vertical walls are desired, forms are necessary to hold concrete in place until in sets. Non-reinforced concrete lining with vertical walls greater than 45 cm should not be used. Curing of all the lined channels is necessary by keeping the concrete or brick layers damp for 8-10 days.

(iii) **Polythene Film (Sheet)** : This when burried in the channels with atleast 10 cm earth, is effective for 2-3 seasons only. It can be adopted as a temporary measure, until lining with brick or concrete is possible, such as in new lift irrigation projects or newly commanded area is sandy tracks.

Underground Conveyance System

This system of water conveyance is recommended for those areas over lined open channels, where soils are sandy, irrigation source is

tubewell and topography is undulating such that some areas of the command cannot be irrigated by gravity flow irrigation.

Measuring Water Flow-rate from Tubewells

The water pumped from the tubewells should be used efficiently without any wastage because of high cost of pumping. The efficient and economical use of underground water for irrigation mainly depends upon accurate measurement of water flow rate. A graph is prepared to determine the water flow rate from tubewells (pipe flowing full). Stepwise procedure is given below :

(a) Measure the inside diameter 'D' of the pipe, in inches.

(b) Measure the vertical distance of the water trajectory 'Y' in inches at a horizontal distance from the pipe end equal to '8 D' shown in Fig. 1.

(c) Read from Fig. 2 the value of the water flow rate 'Q' in gallons per minute (gpm) corresponding to measured value of 'Y' and known value of 'D'.

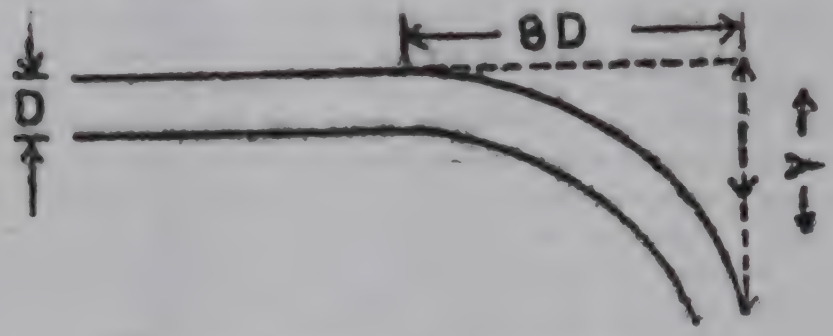


Fig. 1. Measurement of Y at water Trajectory.

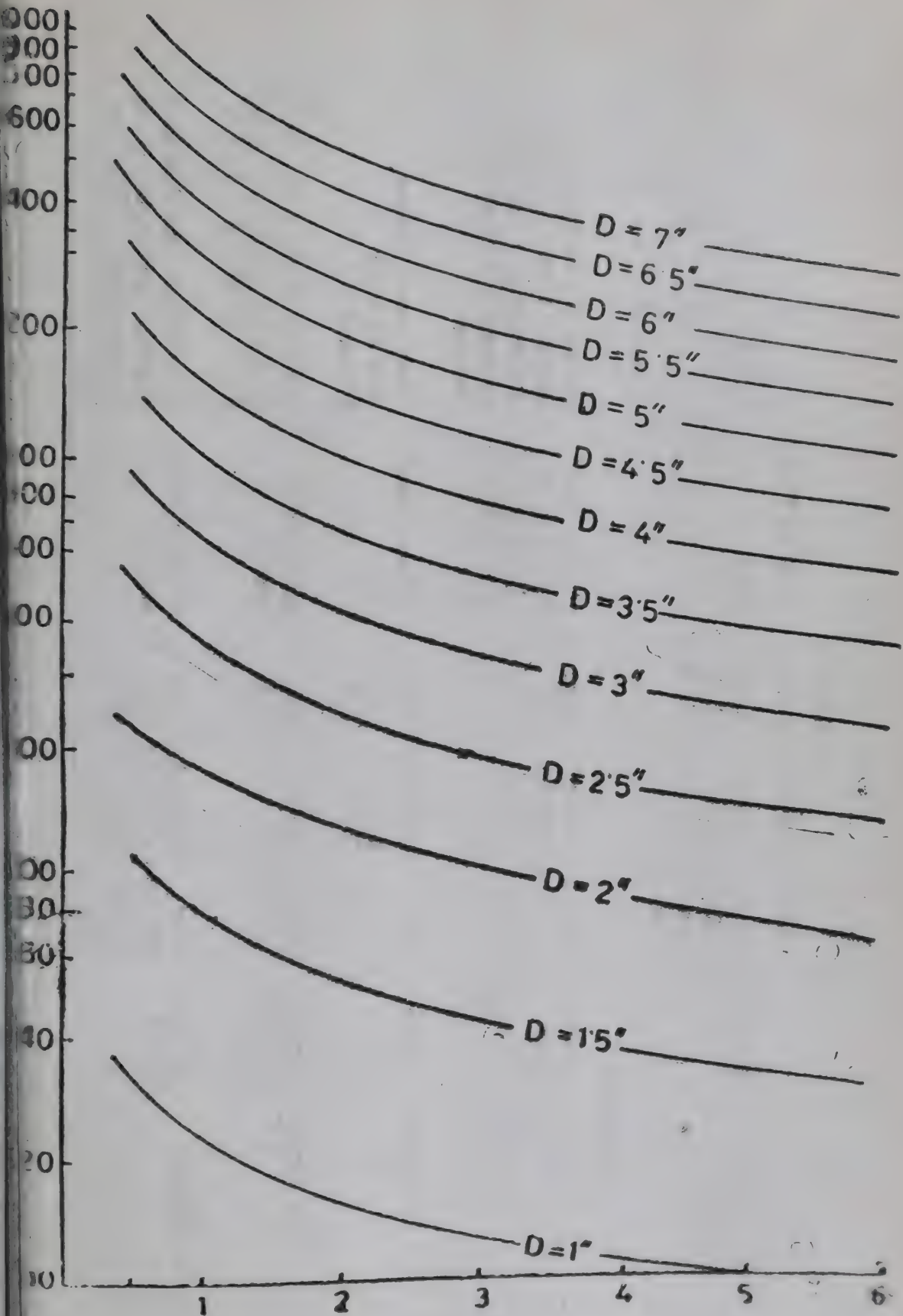
Method of Irrigation

I. **Selection**

(a) **General Method** : The general guidelines for the selection of irrigation method are given in Table 1a.

(b) **Over All Grade Point Method** : The suitability of different irrigation methods with respect to different factors of topography, soil, water, crop, labour, technology, layout and management can be graded in points from 0 (nil) to 5 (excellent) as given in Table 1b.

D=Inside diameter of pipe



Vertical distance of water trajectory 'Y' in inches

Fig. 2. Nomograph for measurement of discharge.

TABLE 1a

General Guidelines for Selection of Irrigation Method

Method of Irrigation	Soil texture	Average infiltration rate (cm/hr.)	Topography & land slope (%)	Stream size (lit/sec.)	Crops	Remarks
A. Surface Method						
(i) Check basin	Medium to heavy	0.5–1.0	Levelled lands less than 0.1	More than 15.0	All crops except those sown on ridges & susceptible to water logging	Less suited to mechanized cultivation. Wastage of land in channels/ridge. Labour requirement, high & problem of drainage.
(ii) Border strip	Medium	1–2	Uniformily graded 0.1–0.3	More than 12.0	All crops except rice	Needs precise grading, long fields are better. Labour saving.
(iii) Furrow	Light to moderately heavy	0.5–2.5	0.3–0.6	More than 1–2	Row crops & vegetable	Good for crusting soils. Provides better aeration and drainage. Leaching not possible.
B. Sprinkler	Very light & sandy	More than 2.5 & upto 20.0	Rolling & undulating (sand dunes)	More than 5.0	All crops except rice & jute	Less suited to canal (Barabandi system). Needs regular power & water supply. Initial cost high.

TABLE 1b

Points to Grade the Degree of Suitability of Different Irrigation Methods

Factor for comparison	Irrigation Methods					
	Check	Border Strip	Furrow	Sub-Irrigation	Sprinkler irrigation	Drip irrigation
1	2	3	4	5	6	7
SURFACE TOPOGRAPHY						
Level land	5	0	0	5	5	5
Moderate land slope	3	4	5	3	5	5
Steep land slope	3+	3+	3+	0	4	4
Undulating land	2	0	2	2	5	4
SOIL						
Light loamy sand	4	3	3	4	5	5
Heavy clay loam	5	4	4	4	4	5
Erosive	0	2	3	0	1	0
Salinity prone	2	2	4	3	2	2
WATER						
Small depth of application	0	0	0	3	5	5
Large depth of application	5	4	3	3	5	3
Water demand of the system	3	2	2	4	5	5
Control rate of application	3	3	3	5	5	5
Water distribution	3	3	4	5	5	5
Losses in water	4	3	3	5	4	5
Use of saline water	3	1	3	0	2	4
SOURCE OF WATER SUPPLY						
Canal	5	5	3	2	2	2
Tubewell	4	3	4	4	5	5
CROPS						
Grain crops	3	4	0	4	5	0
Rice	5	3	0	0	1	0
Sugarcane	3	3	5	4	4	1

1	2	3	4	5	6	7
Tuber crops	3	4	5	5	5	1
Cotton	4	4	5	4	4	3
Vegetables	3	2	4	5	4	5
Fooder	3	5	2	5	5	1
Pastures	5	5	0	5	5	0
Vineyard	3	3	4	3	5	5
LABOUR AND TECHNOLOGY						
Requirement of human labour	2	3	3	5	4	4
Technical understanding	4	4	4	3	2	3
Possibility of automation	1	1	1	5	5	5
Versatility	1	1	1	3	5	3
Requirement of machines	4	3	3	1	2	2
LAYOUT AND MANAGEMENT						
Loss of land	1	2	3	5	4	4
Requirement of material	4	4	4	2	2	2
Requirement of energy	4	4	4	2	1	2
Cost of maintenance	4	4	4	3	1	2
Cost of installation	3	3	3	1	2	1
Cost of operation	4	4	4	2	1	2

+be constructed at contour.

Determination of the best irrigation method to be used from Table 1 b as explained below :

- Determine points for each irrigation method for each of the factors under consideration.
- Drop the irrigation method getting zero point for any of the factors.
- Add the points for all the factors for each of the remaining irrigation methods.
- Determine Over All Grade Point for each irrigation method as :

$$\text{Over All Grade Point (OGP)} = \frac{\text{Sum of Points for all factors}}{\text{Number of factors}}$$

- The irrigation method scoring the highest OGP is best for the given set of factors under consideration. The degree of suitability of different irrigation methods is according to the level of OGP.
- In case OGP for more than one method is same, the method having lower standard deviation is better.

II. Design

(a) Border Strip Method : In this method the field is divided into number of parallel strips separated by low ridges in the direction of slope. The irrigation channel is constructed at the upper end to permit entry of water into each strip.

Recommended Slope, Stream Size and Width of Border Strips for Different Soil Types

Soil type	Slope (%)	Width (m)	Discharge (lit/sec.)	Irrigation depth (cm)	Time for irrigation (mts)
Heavy	upto 0.05	7-8	10-12	7.0	50-55
Medium	0.05-0.10	6-7	12-15	6.0	30-35
Light	0.20-0.50	5-6	15-20	5.0	15-20

Note : (i) Border strip method is more suited to medium textured soils.

(ii) The length may be 60-70 metres.

(iii) Inflow to be stopped when water has advanced to 80 per cent length.

(iv) When discharge is much more than desired, two or more strips may be irrigated simultaneously, otherwise small difference can be adjusted by increasing/decreasing the width of the strip.

(v) When the land slope is more than the recommended and desired grade is not possible to give, either reduce the discharge or increase the width and vice-versa.

Check Method of Irrigation

In this method the field is divided into rectangular or square plots. Normally, one irrigation channel irrigates plots on both sides of the

channel. This method of irrigation is suggested for soils which are heavy or light i. e. the infiltration rate is low or high. The plot sizes and irrigation time for different soil types and steam sizes are given in Table 2. This will ensure uniform and adequate irrigation inclusive of 10 per cent deep percolation losses.

Sprinkler Irrigation

The sprinkler irrigation can be considered better alternative to surface irrigation method when one or more of the following conditions prevail :

1. Undulating land topography such that land levelling cost will be more than Rs. 1600/- per acre.

TABLE 2

Soil type	Stream size			
	14 lit/sec. (0.5 cusec)	Time of irrigation (min)	28 lit/sec. (1.0 cusec)	Time of irrigation (min)
Heavy	200-240 (Sq. m.)	20-25	350-400 (Sq. m.)	17-20
Medium	100-125 (Sq. m.)	8-10	150-180 (Sq. m.)	6-7.25
Light	16-20 (Sq. m.)	1.20-1.60	20-25 (Sq. m.)	1-1.25

2. Soils are sandy/or shallow (infiltration rate is very high)

3. Irrigation source is tubewell with satisfactory quality of water.

4. Available water supply source is small and water is very scarce and where labour is scarce and costly.

5. Wind velocity is generally less than 8 km per hour. Electricity as source of power is available.

6. Saline water upto 6000 micromhos/cm for Kharif crops namely cotton and bajra and 10000 micromhos/cm for Rabi crops namely wheat and barley can be safely applied by sprinkler method, provided the pre-sowing of 4" irrigation has been given by flood method with good quality water.

The initial capital investment cost of sprinkler varies between Rs. 1200-1280 per acre. The operational cost is 1.5 to 2.5 times more

than surface irrigation cost. There is 15-30 per cent saving in water through sprinkler irrigation without any reduction in yield of cereal crops. During hot day time, especially when irrigation water is saline, the irrigation by sprinkler should be given in late evening hours.

This system can also be recommended for areas under lift canal commands which cannot be irrigated efficiently through flow irrigation, by providing pipe outlet of proportional small discharge such that water is allowed to be withdrawn for 12 to 14 hours daily for all the days of canal running.

Use of Sodic Water

(i) Sodic Water-SAR less than 20-RSC less than 10, can be economically used as such in wheat-fallow rotation in sandy loam soils in areas receiving over 450 mm rainfall annually.

(ii) In bajra-wheat rotation, addition of gypsum @ 50% neutralization of RSC of the sodic water has been found to be adequate under the soil agro-climatic conditions as in (i).

(iii) Use of sodic waters with FYM should not be practised particularly in sandy loam and heavier textured soils.

Puddling of Paddy Lands for Minimizing Deep Percolation Losses

(i) For small holding farmers or where area under rice is not more than 5-7.5 acres pudding twice with desi plough or twice with disc harrow followed by planking is recommended.

(ii) For large holdings and in mechanised cultivation puddling with tractor with cage wheel and use of puddler should be used once.

(iii) If power tiller with cage wheel or tractor with cage wheel and disc harrow is used, these should be used twice for good results. During puddling operation there should be 10-15 cm deep standing water in the field.

Problem of Rise of Ground Water Table and Control Measures in Canal Irrigated Areas

Irrigation invariably causes rise in ground water table and the magnitude of rise depends upon amount of rainfall, irrigation efficiency, croping pattern and extent of ground water being pumped. Unchecked rise in water table will lead to water logging. Problem of salinity will also come up where the ground water is brackish. It is, therefore, essential that the water is not allowed to reach within 3 metres from

TABLE 3

District Wise Ground Water Table, Annual Rise and Fall and Per cent Observations/area in 0-3 m Depth Range

District	Average ground water quality (mmhos/cm)	Water table depth June (m)		Av. change (cm/year) (1974-83)	% area in 0-3 m depth June, 1981	Name of blocks having high W. T.
		1974	1984			
Karnal	1.99	5.12	5.72	−7	4.6	
Kurukshetra	1.34	6.81	7.91	−12	4.4	
Ambala	0.69	7.31	7.90	−7	6.3	
Gurgaon	4.97	5.27	6.02	−8	7.4	Punhana, Hodal, Nuh, Pataudi, Hattin
Hisar	6.30	13.12	10.37	+31	3.8	Narnaud
Mahendergarh	3.48	15.12	14.31	+9	0	
Rohtak	8.29	7.68	6.89	+9	15.6	Rohtak, Sampla, Jhajjar Bahadurgarh
Sonepat	4.60	4.25	4.28	+3	43.5	Gohana, Sonepat, Ganaur
Jind	6.44	13.47	9.19	+48	14.6	Safidon
Sirsa	5.06	15.61	10.92	+52	13.3	Baragudda
Bhiwani	7.20	27.45	24.90	+28	0	

+Shows rise in water table

−Fall in water table

ground surface. The average annual rise in ground water table depth (1974-83) and area under 0-3 m water table depth class in June (1983) for different districts of Haryana is given in Table 3. The various blocks of districts (Gurgaon, Rohtak, Hisar, Jind, Sirsa and Sonepat) where the water table is within 3 metres from ground surface are also identified.

Control Measures

1. By minimizing recharge of irrigation losses through adoption of efficient conveyance and application methods as recommended in the Appendix III of package of practices. Adoption of recommended irrigation schedule and cropping pattern is also desirable.

2. To increase the conjunctive use of canal and ground water at Govt. level as well as farmers own level. The mixing of water should be in such a way that resultant E.C. of mixed water does not exceed 10000 micromhos/cm. it is, therefore, recommended that the tubewells should be installed in saline water zone so that this water can be used in conjuction with canal water. The augmentation and conjunctive use programme should be organised in such a way that the pre-sowing irrigation is avoided by mixed water (The mixed water should be applied from 3rd week of December to end of March). The detailed recommendations on use of brackish water have been made in Appendix II of package of practices.

APPENDIX—IV

Recommendations for Machinery & Implements

Paddy

Soil & its preparation : First plough should be done with mould board plough and subsiquent ploughings by desi plough. Before transplanting, the field is flooded with water the crop and accomplish two wet ploughings in standing water. Level the field with a planker so that muddy conditions (good puddle) are created. Use puddler for proper puddling of the field. Puddling will help in maintaining good seedling vigour, control of weeds, and in minimizing water losses due to deep percolation.

Hoeing-Weeding : In early and timely transplanted crop, first weeding, 15 days after transplanting may be done with a paddy weeder. In late transplanted high yielding dwarf varieties hand weeding may be done as paddy weeder can not be used in these conditions. Interculture in paddy is very essential though weeds are controlled by puddling and submergence also.

Harvesting and Threshing : Paddy harvesting is done by manual labour but combines can be used for harvesting and threshing of the crop properly where these machines are available. Improved sickles should be used for manual harvesting of paddy crop.

Bajra

Land and its preparation : First ploughing should be done with mould board plough and subsiquent one or two ploughings/harrowings should be done with desi plough/disc harrow.

Method of Sowing : For better germination bajra crop should be sown by tractor drawn ridger seeder or with a special desi plough on the shoulders of the ridges.

Interculture : Interculture in bajra should be done by bullock drawn blade hoe or manually operated wheel hand hoe. It is better to use these implements 20-25 days after sowing of crop as by that time the weeds are small & easy to control. After every rain use of these implements will be very benefitial for moisture conservation.

Harvesting and Threshing : Bajra crop should be harvested by improved sickle from near the roots and put in heaps in the field to dry.

The ripe earheads may be removed and threshed by animal treating with bullocks or Thresher or drumy.

Other Works : After harvesting the crop, deep ploughing may be done with a mould board plough so that the pests of scalorasia, downey mildew in the soil are destroyed.

Sugarcane

Interculture : One blind hoeing followed by suhaga may be done 7-10 days after planting the sugarcane crop. According to the condition of weeds 2-3 weedings should be done.

Earthing : Slight earthing should be done in the month of may while in the month of June heavy earthing of sugarcane crop should be done with the help of a ridger.

Cotton

Method of Sowing : Acid delinted seeds of different varieties or cotton should be sown with a seed-cum-fertilizer drill/planter. In case these machines are not available then sowing of cotton may be accomplished by a single row cotton drill. The seed should be sown 4-5 cm deep in the moist soil.

Interculture : First dry hoeing should be done with a Kasola or wheel hand hoe before first irrigation. Lateron, after every irrigation interculture in cotton should be done with an adjustable cultivator.

Different types of tractors manufactured in India

Name of Tractor	Make/Model	Cost (Rs.)
Eicher	Eicher—241 NC	1,18,500
	Eicher—242 NC	1,18,400
	Eicher—243 NC	1,25,800
Escort	E—325	1,32,300
	E—335	1,50,300
	E—355	1,84,039
Ford	3600	2,22,000
	3610	2,30,000
H.M.T.	HMT—1811	1,10,000
	HMT—2511	1,23,703
	HMT—3511	1,49,755
	HMT—4511	1,83,465
	HMT—5911	2,28,879
	HMT—2522	1,28,600
Hindustan	Super	2,10,000
Kirloskar	D—4006 K	1,87,000
Mahendra	225 DI	1,25,300
	255	1,32,000
	265 DI	1,45,119
	275	1,61,090
	275 DI	1,62,852
	595	2,00,788
	575 DI	1,98,114
Swaraj	Swaraj—720 (HSMDC)	89,500
	Swaraj—724	1,26,000
	Swaraj—735	1,54,716.88
	Swaraj—855 (MC)	1,90,006.68
TAFE	M.F.—1035	1,60,739.97
	M.F.—245	1,97,006.68
	TAFE—25	1,29,650

Power Tillers available in India

	Name of Firm	Make/Model	Horse power	Cost (Rs.)
1.	Bihar State Agro. Industries Corporation, Patna	Kubota	8-12	64,000
2.	J. K. Satoh Machines Kanpur (U. P.)	Satoh	7-9	58,000
3.	Krishi Engineers Limited, Hyderabad	Krishi	5-8	52,000
4.	Kerala Agro Industries Corporation, Limited Ernakulum	Kubota	5-7	59,000
5.	VST, Tillers Tractors, Limited, Bangalore	Shakti-Janta Mitsubhishi	8-10	62,000

Bullock drawn Agril. Implements

Name of Implements	Price (Rs.)
Implements for land preparation :	
Mould board plough 15 cm.	220
Triphali (3 tyres)	350
Disk harrow (6 disks)	1050
Paddy puddler (Rotary blade 90 cm.)	600
Blade harrow (Bhakar)	350
Clode breaker & levelling equipments :	
Patela & planker (wooden hook)	325
Leveller (Karah) mild steel	315
Buck scraper (wooden)	385
V-leveller (wooden)	210
Wooden float	315

APPENDIX V

Major Constraints and Special Package of Practices for Kharif Dryland Crops

Constraints on Farmers' Fields

1. Establishment of Satisfactory Plant Stand Especially in Bajra Crop

With traditional method of sowing, bajra crop may fail completely due to problem of soil crusting or due to deep burying of seeds and seedlings in the event of rains upto 12 days after sowing. Even if there is no problem of crusting, the crop stand on the farmers' fields with traditional method of sowing is only 50% of the desired crop stand (60,000 to 75,000 plants/acre) for obtaining maximum yield of the crop.

2. Heavy Weed Infestation and Lack of Proper Moisture Conservation Practices : Heavy weed infestation may reduce as much as 50% of the potential yield due to loss of moisture and nutrients.

3. Poor Fertility Management

4. Lack of Timely Plant Protection Measures

Crop-wise Specific Impact Points and Recommendations

Bajra Crop

Variety HHB-50, 60, 67 and 68

I. Stand

The following practices help to establish a satisfactory plant stand :

1. Wider row spacing of 45 cm instead of existing traditional practice of closer row spacing of 30 cm is recommended. In wider row spacing the seed may not be buried too deep due to coverage of soil from the adjacent furrow. Wider spacing also allows interculture and weeding operations with improved implements.

2. Sowing of the crop by a plough with narrow bottom or cotton seed drill or 2-bottom-tractor drawn ridger seeder. In case of 2 bottom tractor drawn ridger seeder the paired row spacing of 30 cm and between two pairs of rows 90 cm is recommended.

3. Gap filling by transplanting of seedlings. The seedlings may be obtained either by raising nursery in separate plots or from the thick stand in the same field or adjacent fields.

II. Weed Control and Moisture Conservation

The practices that control weeds also conserve moisture. The following simple practices are recommended for timely control of weeds and conservation of moisture :

1. Bunding of Fields

Most of the fields in dryland areas are open without any bunds. At places there are ups and downs with undulating topography. Putting of atleast strong boundary bunds around each acre of the field and land shaping of ups and downs could go a long way to conserve the precious and scarce amount of rainfall water. Practice of bunding may be adopted by the farmers in their cultivated fields where there is no problem of shifting of sand dunes. Agro-forestry programme as advocated by Department of Forest should be extended to stabilise the sand dunes and overcome the problem of wind erosion.

2. Preparation of Weed Free Seed Bed

Whenever possible the field should be harrowed well in advance before sowing of the crop when the land fallow during summer or winter months. Post harvest tillage just after harvesting of the previous crop is very useful to reduce intensity of weeds in the following season. Use of blade harrow "Randha" and triphali is very useful in light texture soils as a primary tillage implement or even in medium texture soils as a secondary tillage implement.

Preparation of a weed free seed bed well in advance before sowing of bajra crop also helps in timely planting of crop as soon as rains are received.

In dunal areas where there is a problem of wind erosion, the weeds may be cut by randha during summer so as to provide a straw mulch of the weeds instead of allowing the weeds to grow and to usurp the soil, limited supply of moisture and nutrients.

3. Timely Weeding and Interculture Operations with Improved Implements

Use of hand wheel hoe, bullock or camel drawn blade hoe not only promotes efficient and timely control of weeds with 1/3 reduced

cost of labour, but also helps better conservation of soil moisture by increasing rate of infiltration and reducing loss of water due to evaporation.

Weeding could be started with these implements after 2 to 3 weeks of sowing of the crop when the weeds are young and easily controllable. Interculture operations should be done after every effective shower to break the surface crust and to increase infiltration rate of rain water.

4. Inter Row Water Harvesting in Situ

Making of ridges and furrows with the help of ridger either at the time of planting of the crop or during interculture operations in standing crop helps in harvesting and conservation of moisture **in situ.** This practice also mitigates adverse effect of sometimes heavy down pour of rainfall by providing adequate drainage facility. In slopy fields sowing of the crop should be done across the slope and preferably along contours.

III. Fertility Management

In dryland areas the soil fertility could be improved by raising good legume crops (Guara, Moong and gram) in rotation and by supplemental use of fertilizers.

Application of 16 kg nitrogen and 8 kg P_2O_5 and 10 kg $ZnSO_4$ /acre (once in three years) in deficient soils on the basis of soil test is adequate for obtaining good yield of bajra crop when it has been rotated with a high yielding legume crop of gram or guar. The basal dose of fertilizers should be drilled by local plough at the time of sowing. Half of nitrogen is to be applied as basal and other half as top dressing in standing crop at the time of final interculture and weeding operations, when soil moisture condition is favourable.

For getting maximum response and returns from the use of fertilizers, proper plant stand, maintenance of weed free condition and adoption of moisture conservation practices are must.

Guar and Mung

Mung S9 : It matures in 70-75 days without water stress and yield potential is 4-5 q/acre. With water stress forced maturity is between 60-65 days with yield of 2.5-3 q/acre.

Management practices with respect to seedbed preparation, timely control of weeds and moisture conservation practices and row spacing of 45 cm are the same as recommended for bajra crop. There is no problem of establishment of plant stand in these crops.

Application of 6 kg N and 12 kg P_2O_5, and 10 kg $ZnSO_4$/acre (once in three years) in deficient soils based on soil test serves as booster, for obtaining their satisfactory yields.

Note : The rest of the package of practices are the same as discussed in general package of practices for the various crops.

APPENDIX VI

Control of Stored Grain Pests

Pests and symptoms of attack	Recommendations	Caution/Limitation
1	2	3
Nineteen species of insects infest grains in this region. Of these Khapra, rice weevil, lesser grain borer and rust red flour beetle are serious pests of wheat, *jowar*, rice, barley and maize. Moong *dhora* and Gram *dhora* attack different pulses. Grain moth damages wheat, maize, *jowar*, oats, barley, etc. These insects not only cause loss in weight, but also lower the nutritive value and germinating capacity of the infected grains.	**(A) Preventive measures** 1. Store new grains in clean godown. 2. Fill cracks, crevices and holes with cement. 3. Use new gunny bags. Old gunny bags, if used, must be disinfested by dipping in 0.1 per cent malathion emulsion (one part malathion 50 EC in 500 parts of water) or 0.01 per cent fenvalerate emulsion (1 part fenvalerate 20 EC in 2000 parts of water) or .01 per cent cypermethrin emulsion (1 part cypermethion 25 EC in 2500 parts of water) for 10–15 minutes and dry in shade before filling in grains.	

4. Disinfest empty godown in April-May by spraying 0.5% malathion emulsion (1 part malathion 50 EC in 100 parts of water) on floor, walls and ceiling or by using 7 tablets (3 g each) of Celphos/Phosfume/Quickphos (aluminium phosphide) or 10 litres EDCT mixture or 1.7 kg ethylene dibsromide (EDB) per 1000 cu. ft. (28 Cum.) of empty space with 7 days of exposure period.

5. Mix malathion 5% dust @ 250 g/quintal by weight with grain meant for seed only.

6. Against *dhora*, cover gram or other pulses stored in bulk with 7 cm layer of sand.

7. To protect Dal from Dhora, mix 7.5 ml mustard/groundnut oil per kg Dal thoroughly.

Curative Measures

Fumigate the infested godown with one

Where the empty godown is infested with *Khapra*, it should be fumigated with aluminium phosphide or Killoptera (EDCT mixture) before use. The fumigation should be got done under expert supervision.

Do not mix DDT or BHC dust with seed.

Avoid use of EDB in grains meant for seed.

1	2	3
	of the following.	
	(B) Treatment	
1.	Celphos/Phosfume/Quickphos (aluminium phosphide) @ one tablet (3 gm each) per m. ton or 7 tablets per 28 cu. m. space. Exposure period 7 days.	The fumigants should be used only in airtight stores by specially trained personnel.
2.	EDCT mixture (Kiloptera) @ one litre for 20 quintals grain or 35 litres of EDCT mixture per 100 cu. m. space. Exposure period 4 days.	

21 Jul. 1998

APPENDIX VII

Pests Other than Insects

Pests and symptoms of attack	Recommendations	Caution/limitation
1	2	3
1. **Field Rats** Rats are found in every part of the country. Mainly they are found in godowns, houses and fields. They remain in burrows and have got special power of smell, hear & taste and therefore, it is difficult to control them so easily. They cause heavy losses to wheat, groundnut, maize, sugarcane, etc. House rats destroy stored grains and other products.	Adopt following method on campaign basis against field rats : 1. Close the rat burrows a day before the actual baiting. 2. Next day put zinc phosphide bait in the opened burrows. Smear the grains of wheat, gram, bajra, maize, etc. with sarson oil. Then mix one part of zinc phosphide in 40 parts of grains. Put one table spoonful of this bait material in each burrow after wrapping in a paper. Best time for zinc phosphide baiting is December and May-June. 3. Kill residual population of rats by fumigating with aluminium phosphide (Celphos/Phosfume/ Quickphos) tablets. Put ½ tablet (3 g) or one tablet of ½ gm in each burrow and close it thoroughly. 4. They can also be controlled mechanically by using irrigation water, sticks, iron nets (Pinjre) etc. 5. Biological control is possible by encouraging certain birds, cats, snakes etc. Domestication	

1	2	3
	of cats in houses for rat control is found very effective. *Note* : Organise rat control compaign at village level in May-June & Dec.-Jan. every year.	
2. **Jackals & Porcupines** These are generally active at night and damage sugarcane, maize, Jowar, green vegetables, melons, sweet potato and plant nurseries.	1. Shoot with gun. 2. Spot burrows of porcupines and fumigate them with calcium cyanide dust. 3. Bait with strychnine hydrochloride (3 g in 1 kg meat) against jackals.	Baits against jackals may be prepared in meat of inferior quality.
3. **Flying Foxes** The flying foxes damage more fruits than they actually eat. They feed only on the pulp.	1. Keep strong light in orchards where flying foxes are a serious problem, as they avoid light. 2. Flying foxes have permanent resting places, often many miles away. They can be shot or blasted there with dynamite under technical supervision.	
4. **Birds** Some birds, such as sparrows, parrots, crows, etc. are harmful to many grain crops, vegetables and fruits.	1. Shoot or scare them away by means of mechanical bird scarer or by putting up scare crows (specially dead birds). 2. Destroy their eggs and nests during the breeding season. 3. On small scale vegetable crops and fruit trees can be protected by covering them with nets.	

ps at farmer's field occurs simultaneously.
ously, in such case it is necessary to have
and a fungicide can be mixed together and
e the cost of labour for spraying as well as
ms immediately. In case by mistake two
here may be phytotoxicity or no effective
efore, the knowledge of compatibility of
ll be very useful to the farmers, extension
tate Govt. departments and other related

shion while on right hand side in place of
fashion. To find out compatibility of two
another pesticide from right hand side
vailable there and findout wether they are
orms as well as sucking pests in cotton
r sucking pests phosphamidon is very
lisar. These insecticides are mentioned at
rial number 4 of left hand side and serial
d a letter 'C' which clearly indicates that
r control of bollworms as well as sucking
column no. 4 (right hand side), again at
y of both the insecticides. Similarly, one
s table and thereafter, see the information

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